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JOURNAL OF FARM ECONOMICS

Volume XLII MAY, 1960 Number 2

JOHN DONALD BLACK, 1883–1960

FOLLOWING a heart attack in January, John D. Black, Henry Lee Professor Emeritus of Harvard University, died on April 12, 1960, less than two months before his 77th birthday. Few have had so full and influential a professional life, and one so actively engaged till the end.

John, the fourth of ten children, was born on a homestead in Jefferson County in southern Wisconsin on June 6, 1883. He graduated from Oshkosh Normal School in 1905, taught high school for two years, then went to the University of Wisconsin, where he majored in English. He received his B.A. (with Phi Beta Kappa) in 1909 and his M.A. in 1910. He taught English five years, then returned to Madison as a candidate for the Ph.D. in Agricultural Economics, which he received in 1919. The year before he had gone to Minnesota as Assistant Professor.

During the next nine years Black established himself as a scholar and teacher. He became Chief of the Division of Agricultural Economics at Minnesota in 1921, and built up there a notable faculty and student group. In 1926 he published his path-breaking *Introduction to Production Economics.* His close and abiding relations with the U. S. Department of Agriculture likewise began during this period.

Brought to Harvard in 1927 at the suggestion of Thomas Nixon Carver, Black remained there for the rest of his life. His interests took new directions, including national agricultural policy, food and nutrition, and the special problems of New England agriculture. Major publications included *Agricultural Reform in the United States,* 1929; *Farm Management* (with Clawson, Sayre, and Wilcox), 1947; *Future Food and Agriculture Policy* (with Maxine Kiefer), 1948; *The Rural Economy of New England,* 1951; and *Introduction to Economics for Agriculture,* 1953.

Black's writings typically were pioneer efforts. He had a sense of timing that enabled him to "open up" a field just when it needed to be opened up. Some of his best work is in short articles and papers on specific topics. A number of these were collected and published in *Eco-*

nomics for Agriculture, Selected Writings of John D. Black, 1959, a testimonial volume prepared by former students.

Interwoven with his academic pursuits was a career of participation in government affairs, typically in the role of advisor or consultant. Among the agencies with which his name is linked are the Federal Farm Board, the Agricultural Adjustment Administration, the War Food Administration, the Tennessee Valley Authority, the Forest Service, and the Food and Nutrition Board of the National Research Council.

Professional honors multiplied during the Harvard period. He became President of the American Farm Economic Association in 1932, and of the American Economic Association in 1955. In 1957 the American Farm Economic Association elected its first group of Fellows; prominent among them was John D. Black.

Yet Prof. Black was above all else a teacher. He excelled in making economics relevant to practical agricultural problems. At both Minnesota and Harvard he was the focal point for graduate students in Agricultural Economics. He was always accessible to them, and his home complemented the university as a center of student life. Here his wife, Nina, made her unique contribution, with the aid of their sons Guy and Allen and daughter Margaret (now Mrs. James H. Flanagan). Nor did his interest in his students end when they left St. Paul or Cambridge. His wise counsel continued available to them throughout his life.

Officially, Dr. Black retired as Professor Emeritus in 1956, but this brought no diminution of his activities. His disengagement from teaching enabled him to serve as consultant in many foreign countries, his ports-of-call including Manila, New Delhi, Buenos Aires, and Beirut. He also continued his writing; his last major publication, *Rural Planning of One County: Worcester County, Massachusetts* (with George Westcott) appeared in 1959. He even resumed teaching at Harvard on a temporary *County: Worcester County, Massachusetts* (with George Westcott), appeared in 1959. He even resumed teaching temporarily at Harvard last year, and in December was an active participant in numerous sessions at the Allied Social Science Associations Meetings in Washington.

Black's influence on agricultural economics over the past 40 years has been enormous, and it will continue. As one of his colleagues has written, "for a good many decades to come, and perhaps as long as agricultural economics is taught with decent attention to its origins, students will be hearing the name of John D. Black."

JAMES P. CAVIN
RONALD L. MIGHELL

PROGRAMMING SMALL WATERSHED DEVELOPMENT*

George A. Pavelis and John F. Timmons**
Agricultural Research Service, USDA, and Iowa State University

CURRENT programs for coordinating soil and water management on a small watershed basis provide both challenges and opportunities for improved economic analysis of resource development.[1] Upstream proposals for combining the purposes of flood or other forms of damage control with provision for consumption and nonconsumptive water uses imply a need for multipurpose planning concepts. Heretofore, such concepts have been identified largely with river basin planning. Local sponsorship is a condition for Federal assistance in the Public Law 566 projects and is legalized in most State enabling legislation. The requirement means that planners must reconcile the economic objectives of farmers who control watershed uplands with those of other private or public units affected by upland use.[2]

The crux of watershed planning, however, is the formulation of optimal development programs, which may be defined as programs achieving these objectives of development: (1) maximizing discounted net returns from watershed resources; (2) allocating development costs equitably among various private or public participants;[3] and (3) devising arrange-

* Journal Paper No. J-3742 of the Iowa Agricultural and Home Economics Experiment Station. Project No. 1266.

** The authors sincerely appreciate criticism provided by colleagues on an interdisciplinary team of watershed research: particularly, agricultural engineers R. K. Frevert and Howard Johnson, agronomists W. D. Shrader and Orvis Englestad, and law professor John C. O'Byrne. Also assisting were economists John A. Nordin and Norman Landgren of Iowa State University. F. H. Mendell, State Conservationist of Iowa, U. S. Soil Conservation Service, and staff offered valuable suggestions regarding the Service's field activities in the study area. Finally, a number of coworkers in the Farm Economics Research Division reviewed earlier drafts and suggested important revisions. However, any statements herein should not be construed as official views of either the authors' or reviewers' agencies.

[1] Notable Federal enactments include the pilot watershed authorizations of 1953 and the Watershed Protection and Flood Prevention Act of 1954 (Public Law 566). In this law, small watersheds are construed as drainage areas under 250,000 acres, although contiguous watersheds under this size may be planned jointly. Numerous states have passed legislation enabling the formation of watershed organizations eligible for technical and financial assistance provided under Public Law 566.

[2] This involves distinguishing between methods of land use that may be privately profitable but socially exploitive, both privately and socially profitable or unprofitable, or privately unprofitable but socially desirable. Frank W. Schaller and John F. Timmons, "Economic considerations in agricultural land use from private and public viewpoints," *J. Soil and Water Conservation*, 11:265-70, 1956.

[3] Participants include all individuals, firms and public groups favorably or unfavorably affected by development programs.

ments whereby acceptable programs can be financed, installed and maintained. The purpose of this discussion is to illustrate how the first two of the three objectives might be achieved within a comprehensive planning framework, combining benefit-cost analysis and linear programming. For discussions of problems involved in achieving the third objective, reference is made to other studies.[4]

The Watershed Firm Concept

Comprehensive planning first implies a decision-making agent that can integrate interests of all potential participants. Adopted for this purpose is the concept of a "watershed firm" making planning decisions on the basis of watershed-wide benefits and costs, with due concern that no participants be damaged and uncompensated by reason of programs optimal from an over-all watershed viewpoint. In this sense, a watershed as defined hydrologically is also regarded as an economizing unit made up of two or more private or public "firms."[5]

Watershed planning oriented to the watershed firm idea may be illustrated by recent research completed by the Iowa Agricultural Experiment Station in the 480-acre Nepper Watershed of western Iowa. The main factor in selection of the Nepper Watershed for illustrative planning included the availability of sufficient physical input-output data. Of secondary importance was the fact that some watershed improvements actually installed in 1948 under the Little Sioux Flood Control Program could be re-evaluated within the framework of this methodological study.

Background of the Nepper Watershed Pilot Research

Watershed investigations in Iowa began in 1939 with surveys of the entire Little Sioux River drainage area (4,502 square miles), of which the Nepper Watershed is a tributary.[6] Problems noted in early reconnaissance included the discharge of floodwater and sediment on the Missouri River floodplain, flood overflow along upland streams, and the rapid growth of gullies. Farmland treatment proposed to reduce damages included a general 35-percent reduction in row crops for the area, a 52-percent reduction in such small grains as oats, and a 182-percent increase in forage crops.

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[4] John Muehlbeier, *Organizing for watershed development,* So. Dak. Agr. Expt. Sta. Cir. 133, Jan. 1957. Also, V. C. Herrick and P. M. Raup, *Organizational problems in developing the small watersheds of Minnesota,* Minn. Agr. Expt. Sta. Bul. 437, 1957.

[5] The concept of a watershed firm and the application of benefit-cost criteria to watershed planning have been elaborated previously. John F. Timmons, "Economic framework for watershed development," *J. Farm Econ.,* 36:1170-83, Dec. 1954.

[6] Initial Little Sioux planning data cited are from the Report of a survey of the Little Sioux Watershed in Iowa and Minnesota. 78th Cong., 1st Sess., H. Doc. 268, U. S. Govt. Print. Off., 1943.

Supplementary practices recommended were 33,000 miles of terracing, 560,000 acres of contouring, and such additional measures as afforestation. The benefit-cost ratio for these land-treatment measures alone was estimated to be 2.22, based on average annual benefits of $2,689,707 and annual costs of $1,208,302.

The publicly financed structures proposed for about 27 percent of the basin included 371 dams on major gullies, 73 dams on minor gullies, and 447 structures for diverting water into gullies. The 891 structural measures were credited with probable annual benefits of $191,562. Of this amount, $184,546 represented reduced land damage and the remainder, reduced ditch sedimentation. Estimates of annual structure costs alone totaled $177,200, indicating a benefit-cost ratio of 1.08. Considering both land treatment and structures, the proposed program involved an initial capital investment of about $6 million, annual benefits of $2,881,269, annual costs of $1,385,502, and thus had an estimated over-all benefit-cost ratio of 2.08.

In reviewing the progress of the Little Sioux Program in 12 subwatershed projects completed by 1953, the President's Missouri Basin Survey Commission found, however, that the structures as actually installed showed benefit-cost ratios greater than 1:1 in only six projects.[7] The ratios ranged from 0.51 to 1.59. But land treatment provided net benefits in all of the 12 subwatersheds and showed an average benefit-cost ratio of 3.24, a rate of return considerably higher than the 2.22 land-treatment estimate given above.[8]

Although the same Commission reported favorable benefit-cost ratios of 3.05 and 1.58 for both land and structural treatment in the Nepper subwatershed as one of the 12 projects reviewed, a detailed analysis made by Gertel shortly after the Nepper program was installed indicated unfavorable ratios of 0.59 and 0.83, respectively.[9] Discrepancies here probably involved some differences either in the interpretation of basic land-use–hydrologic relationships or in methods of evaluating benefits and costs, or in both.

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[7] The President's Missouri Basin Survey Commission, *Missouri: land and water*, U. S. Govt. Print. Off., 1953, p. 95.

[8] It should be noted that these Commission findings were of an *ex post* character, in that many data on individual subwatersheds became available only after the fact of installation. Survey parties would doubtless have modified their evaluations of the economic feasibility of development in the Little Sioux Basin had detailed economic information on the particular subwatersheds later improved been available to them also. With this qualification, the Commission's report indicates that if positive net benefits were the criterion for judging the economic feasibility of watershed treatments, no funds should have been allotted to structural improvements in at least six of the Little Sioux subwatersheds.

[9] Karl Gertel, "Benefits and costs of land improvements," Unpub. M.S. thesis, Iowa State Coll. Libr., 1949.

Interdisciplinary Cooperation and Research Hypotheses

Recognizing the need for reliable research to guide planning in the many watershed projects under Public Law 566 and other legislation, the Iowa Agricultural Experiment Station in 1954 initiated a pilot study of the Nepper Watershed. The study jointly involved the Iowa State University Departments of Agronomy, Agricultural Engineering, and Economics and Sociology. The planning model was developed on two principal hypotheses: (1) Given a planning objective of maximum net benefits, it would be possible to formulate programs that would maximize net benefits for any given amount of available expenditure; (2) It could be shown how optimal intensities of land treatment or structure size, as well as optimal reductions in watershed damages, vary with available outlays.

The remaining discussion presents results of testing these hypotheses in the Nepper Watershed by combining benefit-cost appraisals and linear programming. The former were required to eliminate the treatments which failed to promise net benefits or, possibly, involved a greater cost than competitive treatments returning the same gross benefits. Linear programming was used as a project-formulation device. Given the input-output data for each watershed-treatment activity found to yield net benefits, plus specified amounts of land, labor, or capital available for installing and maintaining the treatments, linear programming indicated which measures should be promoted and at what intensity to maximize net benefits from the limited resources available.

Identification and Analysis of Development Possibilities

Predevelopment watershed land use

To facilitate comparison of research results with the Little Sioux Program actually planned in 1947, the same year was selected as the benchmark year from which to evaluate the benefits and costs of treating the Nepper Watershed. Under the 1947 land-use pattern, roughly 53 percent of the total watershed productive area was in corn, 19 percent was in oats, and 28 percent was in meadow. A negligible proportion of the cropland was contoured or fertilized with other than green manures, and no terraces were installed. Rates of sheet erosion were very high, averaging 42 tons per acre for the watershed.[10]

[10] Soil losses were computed from factors developed by Browning which integrate various physical and land-use variables influencing sheet erosion. The method is explained in R. K. Frevert, G. O. Schwab, T. W. Edminster, and K. K. Barnes, *Soil and water conservation engineering*, New York: John Wiley and Sons, Inc., 1955, pp. 122-125.

Associated watershed damages

Land-use systems in effect in 1947 on land above a county bridge allowed 19 acre-feet of runoff to cause annual damages of $385 to the bridge. The same runoff also contributed to floodplain overflow; it mingled with that from lower fields to produce 32 acre-feet of seasonal overflow damaging floodplain crops. The flood volume would cause a maximum average annual damage of $2,803 if the floodplain were cropped continuously to heavily fertilized corn. In addition to these on-site flood damages, 43 acre-feet of floodwater left the watershed annually and caused damages amounting to $140 downstream on the Maple River.

Gullies were also a problem in 1947. Two were advancing at a combined average rate of 0.18 acres per year. Over a 50-year period, they could thus be expected to destroy an additional 9 acres of cropland or farmsteads. The present value in 1947 of gully damage, converted to an average annual basis, was about $137 per year.

With respect to this brief description of the predevelopment situation, data in section 1 of table 1 are corresponding annual costs and returns for the seven watershed farms aggregated; for Monona County as an on-site public interest affected by damage to the bridge; and for the downstream area along the Maple River as an additional public interest. All annual returns and costs (including damages) were computed over a 50-year economic horizon, with privately incurred values discounted at 5 percent and public values at 2½ percent.

The predevelopment data in table 1 indicate how the various watershed farmers and public groups might have viewed a watershed development program. As shown by estimates in column 1, the interests of farmers concerned opportunities for obtaining the benefits of increased crop values, aside from complementary reductions in damages on their own or on neighboring units. Five of the seven farms were being or would be damaged by the gullies, and flood damage to on-site crops was limited to another farm controlling all the bottom land. These six farms, therefore, could also receive benefits of a damage-reducing nature. Only one farm was unaffected by land use on others.

The second column of data in section 1 of table 1 shows that the interest of Monona County in watershed development would be the reduction or elimination of the undue expense of keeping its bridge intact. The third column defines the additional off-site public interest, and the final column aggregates community watershed interests.

At this point, the "planning norm" guiding further research in the

TABLE 1. DISTRIBUTION OF PREDEVELOPMENT RETURNS AND COSTS, AND OPTIMAL DEVELOPMENT BENEFITS AND COSTS AMONG FARMERS AND PUBLIC INTERESTS IN THE NEPPER WATERSHED[1]

Items of returns and costs	On-site farmers	Monona County	Off-site public	Watershed total
	Dollars	*Dollars*	*Dollars*	*Dollars*
Section 1: Predevelopment (1947) resource-use situation				
1. Gross crop values	19,750	0	0	19,750
2. Total normal farm expense	8,717	0	0	8,717
3. Flood damage to bridge	0	385	0	385
4. Gully damages	137	0	0	137
5. Flood damage to crops	2,803	0	0	2,803
6. Off-site flood damage	0	0	140	140
7. Total costs (add items 2-6)	11,657	385	140	12,182
8. Net returns (item 1 less item 7)	8,093	−385	−140	7,568
Section 2: Optimal development, Program C				
9. Gross crop values (I)	+12,171	0	0	+12,171
10. Normal variable farm expense (C)	+4,833	+93	+26	+4,952
11. Flood damage to bridge (C)	0	−273	0	−273
12. Gully damages (C)	−60	0	0	−60
13. Flood damage to crops (C)	−2,803	0	0	−2,803
14. Off-site flood damage (C)	+125[2]	0	0	+125
15. Off-site flood damage (C)	0	0	−77[3]	−77
16. Investment and maintenance (C)	+627	+9	+3	+639
17. Total benefits (+I and −C items)	15,034	273	77	15,384
18. Total costs (+C items)	5,585	102	29	5,716
19. Net benefits (item 17 less item 18)	9,449	171	48	9,668
20. Net benefit per unit cost (item 19÷item 18)	1.69	1.69	1.69	1.69

[1] Program installation costs are in 1947 prices; remaining items are in projected long-term prices.
[2] Increase caused by diversion of on-site overflow with a levee decreasing on-site crop damage by $1,141.
[3] Decrease attributed to upland treatment measures.

Nepper Watershed was presumed to be a maximum value of net watershed returns from agricultural production, discounted over the specified planning period 1947-97. All fixed and variable normal farm expense, and all gully damage, flood damage, and damage-control outlays were charged (as in table 1) as costs of this net output. In these terms, optimal development programs were predefined as combinations of land-treatment measures and structural controls promising a maximum increase in discounted net returns for the watershed community of private and public interests, but subject to any restrictions on expenditure. In brief, this would be a maximum increase in the $7,568 watershed entry for item 8 in table 1, and not necessarily a maximum increase in the $8,093 accruing to farms or maximum decreases in the two negative public entries.

Benefits and costs of land treatment

Benefits and costs of each land-treatment activity were estimated as changes in the returns or costs shown in section 1, table 1, induced by

shifting land use on each of 27 fields within 7 farms from the land-use system followed in 1947, the benchmark year. Benefits of increased productivity were estimated as the increased value at projected prices of corn, oats, or hay (item 1) obtained by adopting new rotations, practicing contour tillage, applying commercial fertilizer, or installing level terraces retaining 2 inches of runoff per storm. Gully-control benefits were the amounts by which average annual gully damage (item 4) could be reduced by the same changes in land use; while flood-control benefits were amounts of reductions in annual flood damage to the county bridge (item 3), to floodplain crops (item 5), and to the off-site area downstream on the Maple River (item 6). Benefits of increased productivity were credited to the farms on which land treatment would be applied; other benefits were credited to the farms or public participants initially damaged.

Costs of land treatment included any additional operating expense of obtaining increased yields (additional to item 2) and annual charges associated with the installation or establishment of terraces or permanent pasture. The costs were allocated among beneficiaries in proportion to the discounted values of total credited benefits, a procedure which assumed that costs would be shared willingly on a basis permitting equivalent benefit-cost ratios on resources contributed by all private and public beneficiaries.

Land-treatment analysis and delimitation

Regarding the particular land treatments given detailed benefit-cost analysis, it was necessary to apply a number of judgment criteria to make the land use planning problem manageable; otherwise, every land use system agronomically feasible on each field would necessarily be evaluated. These systems totaled 1,359 for the watershed, or about 50 for each of the 27 fields. Two primary co-equal criteria were: (1) That any change from the land-use system on any field in 1947 would not be considered for detailed analysis unless annual sheet-erosion rates could be reduced to a productivity-maintenance level of 5 tons per acre; and (2) that any new system would be more profitable to the farmer than his 1947 system. These criteria obviated further consideration of 928 of the 1,359 physical possibilities.

Without presenting details, other criteria included a relative frequency of corn-intensive rotations subject to the 5-ton erosion-control standard imposed above, maximum farm returns per acre, maximum farm returns per dollar of total production cost, and minimum erosion losses. These left 75 land-treatment measures given detailed benefit-cost study from a watershed viewpoint. A few measures were found to yield benefits less than costs on a watershed basis, but the treatments finally isolated for each field were limited to those that promised either maximum net benefits over 1947 conditions or a maximum benefit-cost ratio over 1947 con-

ditions.[11] Thus watershed planning concerned 47 land-treatment activities (1 to 5 per field). The treatments included various combinations of rotational or cover changes, terracing, contouring, and fertilizing.

Structure analysis

Structural alternatives for reducing gully erosion and flood damage were evaluated as the facilities actually installed in the Nepper Watershed in 1948. Classified by purposes, they included four structures controlling gullies in one subdrainage; a drop inlet having the same function in another subdrainage; a chute-spillway to replace the bridge which was being damaged; and three structures, including a levee system, designed to reduce flood damage on the floodplain. All structures were appraised by estimating benefits and costs per installation unit. Units were represented in the case of levees by 1 foot of bank height and in other cases by 1,000 cubic yards of earthfill. The chute-spillway was found to yield benefits less than costs per 1,000 yards of fill; it was thus dropped from further consideration. Those structures with interdependent gully and/or flood-control features were combined as composite measures. Three structural measures to be compared with land treatment resulted.

The Comprehensive Planning Problem

The watershed planning problem as finally presented and as intended to be solved by linear programming involved selecting, from among the 47 land-treatment and the three structural measures delimited above, those measures that would maximize aggregate or watershed-wide net benefits for various limiting levels of program cost.[12] Other limitations included the land resources of the watershed, which were represented by the acreages of each of the 27 fields possibly treated. Each field was defined as a planning restriction because, regardless of available capital, benefits would be limited eventually by each field being treated to maximize net benefits per acre. Final restrictions included limits on feasible structure capacity and maximum benefits from gully control or flood control, as no measure or program could be credited with more of these benefits than it would actually achieve.

Labor was presumed to be non-limiting, inasmuch as labor availability determined by *ex post* farm surveys conducted in 1957 indicated that adoption of labor-intensive treatments would require no more labor inputs than were currently being used.

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[11] The reason for enforcing the two final criteria was simply the isolation of land-treatment measures most expedient for illustrating watershed planning under the contrasting conditions of limited and unlimited development capital.

[12] The variant of programming used for this purpose was that developed by Wilfred Candler: "A modified simplex solution for linear programming with variable capital restrictions," *J. Farm Econ.*, 38:940-55, Nov. 1956.

Results of Comprehensive Programming

Results of the Nepper study show how linear programming can be equally useful in planning watershed projects of three types: (1) Limited scope because of severe capital or other restrictions; (2) expanded scope as increased but still limited capital outlays are considered; and (3) a scope limited only by the availability of resources other than capital.

Critical treatment measures

The choice-criterion for combining the 47 land-treatment measures and three structural measures in alternative programs for the Nepper Watershed was the amount added to program benefits in relation to added costs, or the marginal ratio of benefits to costs. Limited projects for the watershed were formulated as including activities termed "critical" in providing development benefits, whether promoted on upland or bottomland fields. Critical measures were those with relatively high benefit-cost ratios. One steep field, for example, was cropped continuously to corn in 1947 and no conservation practices were followed. Evaluations for this 6-acre field indicated that if land use were changed to permanent meadow, the gross value of the annual yield of hay would exceed by $101 the value of the corn then being produced. Moreover, farm operating costs would be reduced by $26, and the change would reduce average annual flood and gully damage by a total of $163.

The sum of the itemized benefits of $290.55 from treating the field, compared with the average annual cost of pasture amounting only to $9.60, showed that discontinuing corn would net $280.95, or $29.26 for each dollar of the required investment in pasture. The $29.26 was termed the marginal net return, or the addition to net benefits with respect to additional cost. As the marginal rate of return of $29.26 was assumed to be the same for each dollar of the $9.60, it was also the average benefit-cost ratio. No other land-treatment or structural measure was observed to have a benefit-cost ratio as large as 29.26; consequently, a change to permanent meadow on the single upland field was the treatment given first priority.

The concept of adding or substituting watershed-treatment measures on the basis of marginal benefit-cost ratios is further illustrated in figure 1. The horizontal axis measures total program costs. The upper vertical axis measures total program benefits and net benefits in relation to costs. Average and marginal benefit-cost ratios are read on the lower vertical scale. A limited program, designated as program A, involving the single critical shift to pasture described above, would be represented by the points along A in figure 1. (Program A practically coincides with the vertical axis because it involves only $9.60 in annual cost.) The overriding

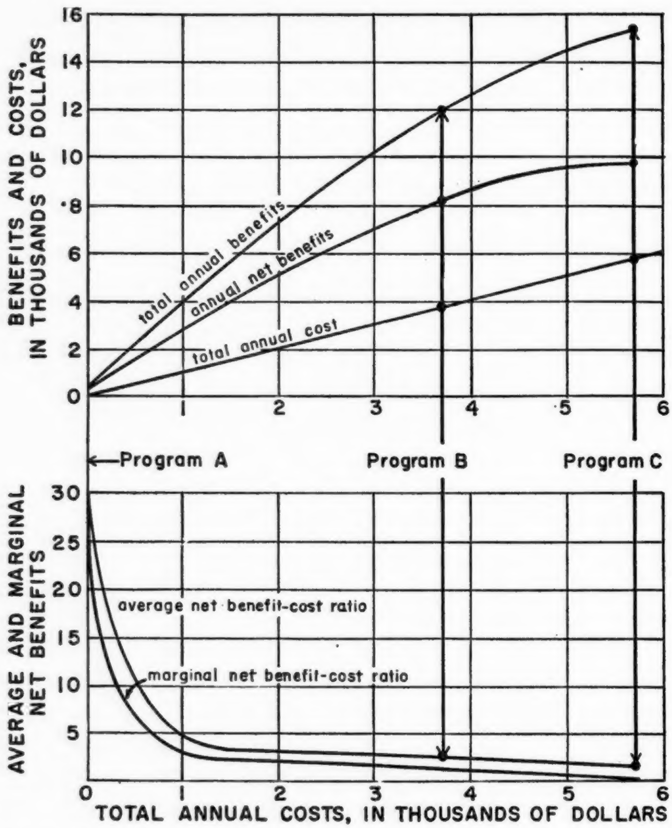

FIGURE 1. BENEFIT-COST ASPECTS OF ALTERNATIVE OPTIMAL DEVELOPMENT PROGRAMS FOR THE NEPPER WATERSHED.

profitability of the single activity that comprised program A is shown also at step 1 in table 2. The table summarizes results of watershed programming in terms of the iterations or steps which successively increased cumulative net benefits (column 9).

Intermediate optimal programs

As outlays greater than $9.60 were allocated, it was economic to consider treatments with marginal net benefit-cost ratios less than $29.26, until no treatments remained that would yield additional net benefits. For program B in the top section of figure 1, for example, a total annual outlay of $3,706 allocated most economically would have produced total benefits of $11,937 and net benefits of $8,231. The corresponding over-all or average net benefit-cost ratio would amount to 2.22, and the marginal ratio (for the last treatment added) to 1.46, as shown in the lower section

TABLE 2. ALTERNATIVE DEVELOPMENT PROGRAMS FOR THE NEPPER WATERSHED, BASED ON BENEFIT-COST APPRAISALS OF ALTERNATIVE ACTIVITIES AND DERIVED THROUGH LINEAR PROGRAMMING

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Program formulation			Marginal activities			Cumulative (program) activities			
Steps or programs	Activity added	Activity deleted	Added level	Cost	Net benefits	Net benefits ÷cost	Cost	Net benefits	Net benefits ÷cost	Total benefits
	(code) (P_j)[1]	(code) (P_j)[1]	(units)	(dollars)	(dollars)	(6)/(5)	(dollars) $\Sigma(5)$	(dollars) $\Sigma(6)$	(9)/(8)	(dollars) (8)+(9)
1(A)	4	52	1.00	9.60	280.95	29.26	9.60	280.95	29.26	290.55
2	17	60	1.00	8.25	184.44	22.35	17.85	469.39	26.07	483.24
3–17	—	—	—	2,573.	5,963.	2.31	2,591.	6,428.	2.48	9,019.
18	9	55	1.00	324.91	570.35	1.75	2,916.	6,998.	2.40	9,914.
19	26	25	1.00	315.21	523.52	1.66	3,231.	7,522.	2.33	10,753.
20	40	74	1.00	449.68	670.60	1.49	3,681.	8,193.	2.23	11,874.
21(B)	35	70	0.14[2]	25.92	38.00	1.46	3,706.	8,231.	2.22	11,937.
22–33	—	—	—	236.03	35.29	0.10	5,363.	9,644.	1.80	15,007.
34	13	58	1.00	116.35	11.65	0.10	5,480.	9,656.	1.76	15,136.
35(C)	12	57	1.00	237.25	11.73	0.05	5,716.	9,668.	1.69	15,384.

[1] Activities coded $P_j=1, 2, \cdots 47$ denote "real" land treatment activities, which include different combinations of crop rotations, conservation practices and levels of fertilizer application. Activities coded $P_j=48$, 49 and 50 represent structural measures. Disposal vectors for restrictions are denoted by $P_j=51, 52, \cdots 81$.
[2] Activity P_{35} is added at only 14 percent in step 21 to limit program B to a cost of $3,706 as described in the text.

of the same figure. Table 2 indicates that 21 programming iterations were required to derive program B, and that at least 21 alternative watershed programs involving no more than $3,706 could have been presented to project participants.

As $3,706 was also the outlay involved in the Little Sioux Program partially installed in the Nepper Watershed in 1948, the relations of figure 1 could be used to evaluate that program. Instead of the gross benefits of $11,937 and maximum net benefits of $8,231 (program B, figure 1), the 1948 program, according to the President's Missouri Basin Survey Commission, provided gross benefits of only $8,368 and net benefits of only $4,662. It should be noted that, even though the program as actually planned had an overall favorable gross benefit-cost ratio of 2.10 for the outlay of $3,706, it would return $3,569 less in net benefits than if the $3,706 were allocated optimally as indicated on the curves. These comparisons are not made to criticize earlier planning in the watershed, but to suggest that such techniques as mathematical programming can help avoid the formulation of projects yielding anything less than maximum net benefits for a given outlay.

An optimal program with capital nonlimiting

If planning in 1948 could have proceeded without regard to the outlays involved in any of the 47 land-treatment measures and three structural measures specified, program C would have been the optimal plan of watershed development. Planning with no restriction on expenditures means that any treatment with a net-benefit–cost ratio greater than zero can be undertaken, because net benefits will be increased thereby. For program C in figure 1 and table 2, annual gross benefits are $15,384; total program costs are $5,716; and net benefits amount to $9,668. The average or over-all net-benefit–cost ratio is 1.69, and the marginal net-benefit ratio for the last activity added is near zero. Any expenditure above $5,716 could not increase net benefits above $9,668.

Figure 1 also shows that, although the average and marginal benefit-cost ratios of program C are well below those of programs A and B, the net benefits of C are considerably greater. This again emphasizes that the object of planning to maximize net benefits is not to maximize the average benefit-cost ratio as such, but to maximize it with respect to a given quantity of funds or total program expenditure. The latter approach assures a maximum of net benefits because it involves the addition or substitution of alternative program activities in descending order of their marginal net returns (column 7, table 2), with the extent of addition or substitution governed by the available expenditure being allocated. In any case, expenditure should not exceed the amount at which any additional benefit obtained would be less than the additional expenditure

involved, or where the marginal net-benefit-cost ratio becomes zero or negative. As described above, in the Nepper Watershed study such a point was essentially reached with program C.

The relation of complete development under program C to the initially summarized predevelopment situation in the Nepper Watershed can be noted by referring to table 1. Optimal changes in predevelopment returns and costs are represented by details on program C in section 2. Because of proportional cost sharing, all farmer and public interests would benefit absolutely and proportionally; the latter condition is indicated by equal rates of return of $1.69 per dollar of cost. The final column of project data shows that, to obtain a maximum of $9,668 in net benefits distributed as shown among various participants, only flood damage to on-site crops would be eliminated. The remaining damages would be reduced to tolerated levels greater than zero.

Land treatment under alternative programs

The relation of optimal cover conditions and conservation practice intensities to the maximization of net benefits in the Nepper Watershed is diagrammed in figure 2. The horizontal axis refers to total annual program costs and the left vertical axis to annual net benefits. The right vertical axis measures the relative proportion of the watershed area devoted annually to the production of corn, oats or forage, as well as the proportionate area contoured, terraced, or fertilized. Under predevelopment conditions of 1947, for example, figure 2 (at a zero outlay) shows that 53 percent of the watershed productive area was in corn, about 19 percent was in oats, and 28 percent was in meadow. The conservation treatments of contouring, terracing and fertilizing were almost nil.

Obviously, program A as limited to an expenditure of $9.60 would have altered watershed land use and hydrologic conditions very little, although net benefits would be very high ($29.26) for each dollar invested (see figure 1). Program B, which involved an outlay of $3,706, would require that the area annually in corn be increased to 64 percent. The area in oats would be decreased to 12 percent, and meadow would be decreased to 24 percent. Complementary conservation treatments needed to justify the significant increase in the acreage of corn can be read upward from B in figure 2.

A feature of figure 2 that should be of partricular interest to conservation economists is that the percentages plotted do not necessarily increase or decrease monotonically as greater outlays are allocated in a manner to maximize net benefits. Program C, or that involving a maximum justified outlay of $5,716, suggested that the relative area in meadow be about the same (28 percent) as the predevelopment area. This contradicts a narrow but common view of conservation as simply a decreased area in row

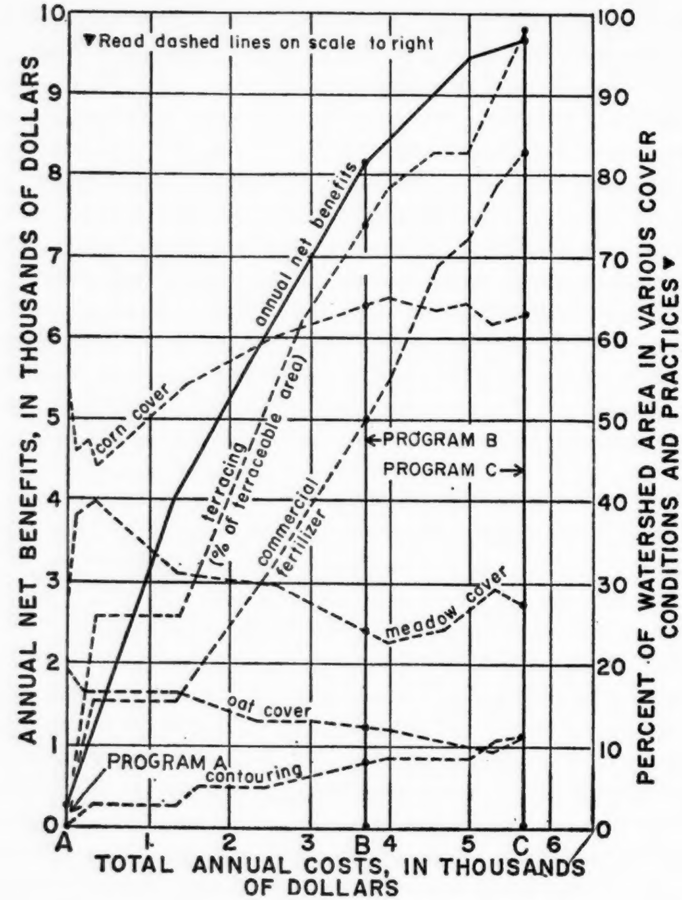

FIGURE 2. WATERSHED COVER CONDITIONS AND LAND-USE PRACTICES CONSISTENT WITH OPTIMAL DEVELOPMENT PROGRAMS.

crops and a corresponding increase in grass or legumes. Figure 2 reveals that the area in meadow would increase rapidly if funds limited to about \$400 were allocated optimally, then decline until expenditure reached \$4,000, then increase until it reached \$5,300, and decline again thereafter, until the \$5,716 amount involved in program C was allocated to maximize net benefits. Over most of the range, increases in the practices of terracing, contouring and fertilizing, complemented with a more extensive production of corn, were required for maximum net benefits.

Structures and benefit maximization

The only structural measure found necessary to maximize net development benefits in the Nepper Watershed research was a levee built to a

height of around 4 feet. The basis for this conclusion was that, in general, upland treatment measures were more effective than structures in producing aggregate (yield-increase and damage-reduction) benefits, although the structures would appear justified if considered independently on their own damage-reduction merits.

The programming conclusions would require, however, that the upland flood prevention measures and the levee be jointly installed and maintained for their maximum effectiveness. If the terraces were not installed, or were allowed to deteriorate, structures in addition to the levee system could be considered as flood-prevention measures provided their combined flood-control and other benefits exceeded costs.[13]

Conclusions

Because all structures planned in 1948 for the Nepper Watershed were actually installed under the Little Sioux Program, the foregoing research results are too late for application in the planning of that watershed. Nonetheless, studies of this nature are useful in establishing economic guidelines for future watershed planning. And even with regard to the Nepper Watershed itself, it was possible to recommend that land use as now observed could be shifted profitably to the same pattern resulting from implementation of program C as discussed. Such adjustments could be credited with only limited gully or flood-control benefits; they are justified largely on the basis of increased crop yields obtained throughout the watershed.

The planning approach taken in the Nepper research is most useful in those situations in which any proposed watershed treatment or improvement is regarded only as an alternative, and a number of alternatives are evaluated for each treatment area or structure site. The study not only showed how to select measures promising some net benefits, but also how to extend the range of selection and combine measures to render aggregate net benefits a maximum. The maximization objective was achieved

[13] Professor Howard Johnson reminds us that the use of linear programming raises some problems in dealing with structures as follows: "It appears to me that the 4-foot levee height is the result of the programming technique and bears limited relations to hydrologic events which usually are expressed as probability functions. It would appear, therefore, that the value of a foot of dike is not a linear function. Considerable further research is needed in approaching this problem."

Probability considerations also call into question the propriety of using maximum average annual net benefits as the only criterion for optimally combining land treatment and structural measures for flood control. Project participants adverse to risk might prefer a combination with (a) lower annual benefits but also with less benefit variance to (b) one providing maximum average annual values but also subject to wide variation because of only partial or no control over flood events. In general, combination (a) would be represented by a structure-intensive watershed program, while combination (b) would involve an intensive land treatment program.

within restrictions on available land and other resources, given cost-sharing standards, and the welfare requirement that projects not leave anyone damaged and uncompensated.

Programming recommends itself more strongly to field application, however, in that it simultaneously resolves within a multipurpose framework planning questions that involve program feasibility, combination of measures or purposes, program scale, and project priorities. These are the important economic questions confronting both technicians and administrators charged with the effective conduct of current watershed programs.

EVALUATING A FARM MACHINE PRIOR TO ITS INTRODUCTION*

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ONE TYPE of applied research commonly undertaken by agricultural economists involves cost analyses of various farm machines. The objective of such studies is to determine the relationship between cost and output. These studies have proven in the past to be quite useful in helping farmers make decisions as to the expected profitability of machines.

Research Is Often Too Late

Most research of this type has been accomplished by a survey of farmers using the machine or by some type of time study of the machine in the field or on the farm. In either case, the research is done after the introduction of the machine, and the results of the research usually come out at least two years after the machine is in use. The shortcomings of this procedure are obvious. Data which would be helpful to farmers in deciding on the purchase of a machine often are too late. The research is quite useful to those who have not yet purchased a machine; it is much less useful, if useful at all, to those who have already purchased the machine.

The objectives of this paper are: (1) to suggest a procedure whereby machine performance data can be obtained by experiment stations and released to farmers before or at the time the machine comes on the market, and (2) to show how information from previous work can be combined with new data in determining cost relationships.

The approach spelled out in this paper would be applicable to many different kinds of farm machines. The illustration used here is a type of tobacco harvester.

Previous Tobacco Harvester Evaluation

Tobacco harvesting has high labor requirements; about 150 to 200 man-hours per acre are being used to harvest tobacco and place it in the barn for curing. Yet until recent years no significant efforts toward the mechanization of tobacco harvesting had been made.

A type of self-propelled, four-row tobacco harvester was introduced in 1954. A research study was carried out in 1956 to compare costs of harvesting tobacco using this machine with costs of harvesting by the

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common hand method.[1] By the time the research results were published early in 1957, several thousand of these harvesters were in use in the flue-cured tobacco area.

The study showed that variable costs were reduced from 13¢ per stick with the hand method to 11¢ per stick with this machine.[2] Purchase of this machine was not justified, assuming a 5-year machine life, unless the machine could be used to its full capacity. In fact, none of the farmers was found to be using the harvester on enough acres to reach the point where machine harvesting was as cheap as hand harvesting. Some farmers considered their harvesters a good investment, either because they were getting better than average results from their machines or because of nonpecuniary reasons. However, many farmers had learned what the research showed, that investment in a harvester was not profitable. Some farmers stopped using their machines, and others sold them at greatly reduced prices. Sales of new machines declined abruptly, and manufacturers of the machine found themselves with overly large supplies of unsold harvesters.

Preliminary Appraisal of New Harvester

A new type of harvester which enabled one man to perform the entire harvesting operation was in the developmental stage in 1957. At this date the harvester was a one-row, one-man machine, steered by the worker's feet.

Personnel of the company developing the machine talked with members of the Agricultural Economics and Agricultural Engineering Departments at North Carolina State College concerning the possibilities of such a machine, and an informal study was initiated in 1957. Time trials were run with the machine under two methods, one man alone and one man with a helper. Adjustments and changes in the machine were made from day to day in order to try new ideas.

From this informal study, a written report was submitted to the company, and the results were discussed with their representative. The results indicated that the machine could not be economical if two men were used. Productivity was not increased enough by the second man to warrant use of this method.

It was found that, when only one man was used, labor requirements were about one-half of what could be expected for hand harvesting. On this basis, it appeared that the machine had a potential market. Using

[1] W. T. Chumney and W. D. Toussaint, "Machine or Hand Harvesting Tobacco," A. E. Info. Ser. No. 57, N.C. State Col., Raleigh, N.C., June 1957.

[2] *Ibid.*, p. 9.

our data on machine performance, a series of estimates were made of what farmers could afford to pay for such a machine, given certain acreages. That is, machine prices were listed which would equate the cost of harvesting by machine and by hand for a given expected life of equipment and given acreages harvested.

The experimental one-row machine was found to be highly unstable, overturning several times on terraces or on highly-ridged rows. For this reason it appeared that a model for harvesting at least two rows at a time would be preferable. Also, the company felt that a two-row machine could be built for less than twice the cost of a one-row model. The engineers felt that a two-row model could be built light enough and maneuverable enough so that one of the men could steer it with his feet.

As a consequence of the experience gained in 1957, the company developed a two-row model embodying the general principles of the one-row machine. This experimental model was completed and ready for trial in the summer of 1958.

The Two-Row Experimental Model

In order to obtain cost estimates of the harvester before its release, the company agreed to cooperate with the Experiment Station in a research effort. The company planned to try the machine under different field conditions and in different parts of the flue-cured area so that their dealers and interested farmers might get a chance to observe the harvester in operation. Two methods were to be used, a two-man method and a three-man method, in order to determine the performance with each method.

With this two-row harvester, two workers are seated on the machine, and the worker on the left steers the machine with his feet. The tobacco leaves are removed (primed) by the workers and placed in bundles or hands with from three to six leaves per hand. These hands are then tied, with the aid of a semi-automatic looping device, on sticks placed in front of the workers. Both workers fill their sticks at the same time. When the two-man method is used, each worker ties the string to the end of the stick nearest him as the sticks are filled. Then the workers get up, place the full sticks on the harvester, and put an empty stick in the stick-holding rack in front of them. The full sticks must be unloaded later to a truck or trailer at the end of the rows, and the second end of the string is tied to the stick at this time. When the three-man method is used, the third man takes the full sticks off the machine, puts two empty sticks back on the machine, ties the ends of the strings to the full sticks, and places the full sticks on a trailer behind the machine. These operations are performed by the third man while the other two workers are filling

the next two sticks. The three-man method requires that every fifth row of tobacco be left out to provide space for the trailer. However, the two-man method can be used without the fifth row being left out.

The problem in evaluating the harvester was to determine the productivity of the two-row harvester in such a way that the results could be compared with those for hand harvesting from an earlier study.[3] As an aid in determining the size of sample needed to do this, an estimate of variance of productivity per man-hour expected was available from the previous year's data. These data indicated a variance of productivity in sticks per man-hour of about 7, and we were willing to accept a confidence interval of 1.5 sticks of tobacco per man-hour at the 95 per cent level. Using this information, it was estimated that about 14 or 15 observations would be needed to establish the expected machine output with the degree of precision desired. Data for a set period of time each day were desired for convenience in analysis. Thus, the experiment was set up to obtain information for 15 periods, each of 2½ hours, for each method. Observations were taken both in the morning and in the afternoon for each method to eliminate the effects of differences in productivity at different times of the day. During the observation periods dealers could watch the machine but did not interfere with the operation. The rest of the day was used for demonstration purposes. In addition, each method was used for a full 10-hour day at the end of the observations. The longer period was tried to see if there might be any obvious bias due to the use of time periods shorter than a whole day. The trial showed no appreciable difference in productivity.

The same two men were used as harvesters or primers throughout the experiment.[4] This leaves the question unanswered as to the performance of these men relative to others. However, our judgment was that these men were of about average priming capability.

All observations in this study were made for removing leaves from the middle of the plant. Thus, all comparisons between the hand method and the two-row harvester are for middle leaves. Ground leaves and tip leaves require slightly more harvesting labor, but the relative differences would be expected to be the same for both methods.

A complete log of turning time, break time, and breakdown time during the 2½-hour periods was kept. This time is designated as nonproductive time in table 1. Also, the operations of placing the full sticks on the

[3] *Ibid.*

[4] It would have been desirable to use different primers in order to establish among-primer variability for harvester output. This was not possible because of time limitations. At least one day of practice would probably have been necessary to get an accurate idea of a primer's performance. With limited time and only one machine, it was necessary to use the same two primers throughout the entire experiment.

harvester, placing the empty sticks on the machine, and tying and unloading the sticks were timed for the two-man method.

Comparing labor requirements

The number of leaves and hands placed on a stick affects the harvesting time per stick of tobacco. Thus, the basic problem in determining comparative labor requirements was to estimate the number of sticks of tobacco harvested in a given period of time for sticks having the same number of leaves and hands as for hand harvesting in the earlier study. The hand-method study was made in an area where farmers used a slightly different combination of hands and leaves on a stick than was

TABLE 1. AVERAGE TIME DATA FOR TWO-MAN AND THREE-MAN METHODS FOR TWO-ROW TOBACCO HARVESTER, 1958

Item	Two-man method	Three-man method
Time to place two full sticks on harvester, place two empty sticks on rack, and tie and unload two sticks (seconds)	38.6	[a]
Nonproductive time (turning, break, and repair) (seconds per hour)	410	441
Nonproductive time (per cent)	11.4	12.2

[a] These operations are performed by the third man while the two primers continue their work.

found in this study. The hand-method estimate available was for sticks having 37.4 hands and 3.31 leaves per hand, an average of 123.8 leaves per stick.[5] In this study the observed averages were 32.2 hands, 3.66 leaves per hand, and 118.4 leaves per stick for the two-man method and 31.9 hands, 3.67 leaves per hand, and 117.4 leaves per stick for the three-man method.

To adjust productivity estimates for differences in combinations of hands and leaves, it was necessary to determine the functional relationship between production in sticks per hour and leaves per hand and hands per stick. Before collecting the data, it was anticipated that the combinations of hands and leaves used by farmers on whose farms the data for the two-row harvester were to be obtained would differ from the same data from the study of hand harvesting.

To determine the relationship between harvest time per stick and leaves per hand and hands per stick, a stop watch was used to time the harvesting for 20 sticks in each 2½-hour period.[6] The sticks for each observed time were tagged, and the leaves and hands for each stick were

[5] Chumney and Toussaint, *op. cit.*, p. 9.

[6] This was done randomly ten different times, 2 sticks each time; i.e., for each time observation there were two observations on the number of leaves and hands.

counted at the end of the trial period. There were 300 stick-observations available for each method, from which the following regression equations were obtained. For the two-man method:

(1) $Y_1 = 18.946 + 2.4185X_1 + 8.352X_2$ ($R^2 = .35$),

and for the three-man method:

(2) $Y_1' = 17.155 + 2.4122X_1' + 8.2558X_2'$ ($R^2 = .38$),

where the Y_1's are the number of seconds to prime and string two sticks of tobacco, the X_1's are the number of hands per stick, and the X_2's are the average leaves per hand for each stick of tobacco. The *b* coefficients are significant beyond the .005 level and are nearly identical for both methods, as would be expected. The constant terms for the two equations do not differ significantly, although the slightly higher constant term in equation (1), reflecting the tying time for the two-man method, would be anticipated. For these reasons, the equations appear to be logical.[7]

To estimate the productivity of the two-row harvester with both methods, it was necessary first to estimate the priming and stringing time per two sticks, using equations (1) and (2) and 37.4 as the value of X_1 and 3.31 as the value of X_2 so that a proper comparison could be made with data for hand harvesting.[8] The estimates of priming and stringing time for two sticks were 137.0 for the two-man method and 134.7 seconds for the three-man method.[9] In addition to the 137.0 seconds needed for harvesting two sticks with the two-man method, 38.6 seconds were needed to place two full sticks on the harvester and to tie and unload two sticks.

The number of sticks harvested in an hour is equal to the number of productive seconds in an hour divided by one-half of the harvesting time for two sticks (priming and stringing time plus time to tie strings and load and unload sticks). Productive seconds per hour is 3600 minus the amount of time needed for repairs, break time, and turning at the ends of the rows. Thus, the predicted productivity for the two-man method in sticks per hour is:

$$(3) \qquad \hat{Y}_2 = \frac{3600 - a}{(\hat{Y}_1 + c)/2} = \frac{3600 - 425}{(137.0 + 38.6)/2} = 36.2$$

[7] There are many other factors which affect priming time and which are difficult to measure, such as number of suckers on the plant, weeds, terrain, and the number of leaves primed per stalk. These and other factors are responsible for the large percentage of unexplained variability.

[8] Chumney and Toussaint, *op. cit.*, p. 9.

[9] The variances associated with these estimates were 3.32 for the two-worker method and 2.86 for the three-worker method, where

$$s_{\hat{Y}_1}^2 = s_{y1}^2\left(\frac{1}{n} + c_{11}x_1^2 + c_{22}x_2^2 + 2c_{12}x_1x_2\right).$$

The x_i's are deviations from the means.

where a is the nonproductive time per hour, $\hat{Y}_1$ is the estimated priming and stringing time per two sticks from equation (1), and c is the time to load two full sticks on the harvester and unload two sticks from the harvester to a truck or trailer (38.6 seconds, table 1). A nonproductive time of 425 seconds per hour was the average found for both methods (table 1). Since there appeared to be no reason for the nonproductive time to vary between methods, 425 seconds was used as the estimate of nonproductive time for both methods. Productivity per man-hour for the two-man method is (36.2)/2 or 18.1.

The approximate variance of $\hat{Y}_2$, a ratio, is:[10]

$$(4) \qquad s_{\hat{y}_2}{}^2 = \left[\frac{3600 - a}{(\hat{Y}_1 + c)/2}\right]^2 \left[\frac{s_a{}^2}{(3600 - a)^2} + \frac{s_{\hat{y}_1}{}^2 + s_{\bar{c}}{}^2}{(\hat{Y}_1 + c)^2}\right] = .3309.$$

This is a relatively low variance, and the approximate 95 per cent confidence interval (with 14 d.f.) for the estimated productivity per hour is 34.9 to 37.4, a fairly narrow interval.

The only two factors affecting productivity of the three-man method are harvest time and nonproductive time, since the third man performs the function shown as c in equation (3) for the two-worker method. Predicted productivity for the three-man method in sticks per hour is:

$$(5) \qquad \hat{Y}_2{}' = \frac{3600 - a}{\hat{Y}_1{}'/2} = \frac{3600 - 425}{(134.7)/2} = 47.1,$$

where the variables are as defined in equation (3). Production per man-hour with the three-man method is (47.1)/3 or 15.7, compared to 18.1 for the two-man method.

The approximate variance of $\hat{Y}_2{}'$ is:[11]

$$(6) \qquad s_{\hat{y}_2}{}'^2 = \left[\frac{3600 - a}{\hat{Y}_1{}'/2}\right]^2 \left[\frac{s_{\bar{a}}{}^2}{(3600 - a)^2} + \frac{s_{\hat{y}_1}{}'^2}{(\hat{Y}_1{}')^2}\right] = .6202.$$

The approximate 95 per cent confidence interval (14 d.f.) is 45.4 to 48.8, again a relatively narrow interval.

Estimates of expected productivity of either method with different combinations of hands per stick and leaves per hand are easily made by plugging in different values of X_1 and X_2 in determining estimated harvesting time. In this way, farmers can be shown the productivity they

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[10] W. G. Cochran, *Sampling Techniques*, John Wiley and Sons, Inc., New York, 1953, p. 117. Since estimates of a, c, and $\hat{Y}_1$ are independent, no covariance term is necessary.

[11] Since estimates of a and $\hat{Y}_1{}'$ are independent, no covariance term is necessary.

can expect for different combinations of hands per stick and leaves per hand.[12]

The harvesting process is not complete until the sticks of tobacco are placed in the barn. Data were available for barning time with the hand method. Barning time was estimated at .016 man-hours per stick for the two-row harvester, based on previous information on barning time for other harvesters and the size of crew likely to be used for barning with the two-row harvester. The estimated harvesting and barning labor requirements are given in table 2. It is estimated that the two-man method reduces labor requirements by about 62 per cent and the three-man method reduces labor by about 57 per cent relative to the hand method.

Table 2. Productivity Comparisons for Hand Harvesting and the Two-Row Harvester with Two Men and Three Men[a]

Method	Sticks harvested per man-hour	Man-hours per stick harvested	Man-hours per stick harvested and barned	Man-hours per acre harvested and barned (928 sticks/acre)
Hand	6.0	.167	.188	174
Two-man	18.1	.055	.071	66
Three-man	15.7	.064	.080	74

[a] These data are for leaves from the middle of the stalk and are slightly lower than the average requirements for leaves from the entire stalk.

Cost estimates

Farmers may purchase a harvester on the basis of the reduced labor requirements alone. However, most are concerned with the relative cost of harvesting by alternative methods and wish to know the number of acres needed to make a harvester pay.

The average wage paid laborers on the harvester will no doubt exceed the average wage paid for hand harvesting. No wage data are available for the two-row harvester; thus, estimates were necessary. It was assumed that the average wages would be \$.70, \$.90, and \$.85 per hour for the hand method, the two-man method, and the three-man method, respectively.

Other variable costs of gasoline, oil, grease, farmers' service labor, and repairs were estimated at \$7.13 per acre for the two-man method and \$5.98 per acre when three men were used. There are no variable costs other than labor for the hand method. Total variable costs per acre were

[12] This is an additional and important point. However, it is distinct from the problems of this paper. A discussion of this aspect can be found in P. S. Stone, "An Economic Analysis of a Two-Row Mechanical Tobacco Harvester," Unpub. M.S. thesis, N.C. State Coll. Libr., Raleigh, 1959.

estimated at \$66.53 for the two-worker method, \$69.08 for the three-worker method, and \$122.13 for the hand method.

The company is selling the harvester for \$1850, and the three-man method requires at least two trailers at \$50 each. Obsolescence is an increasingly big factor in depreciation of farm equipment; tobacco harvesters are no exception. For this reason, an estimated life of 5 years was used in determining depreciation. A salvage value of \$100 was assumed, and 5 per cent of the initial cost was charged for interest, taxes, and in-

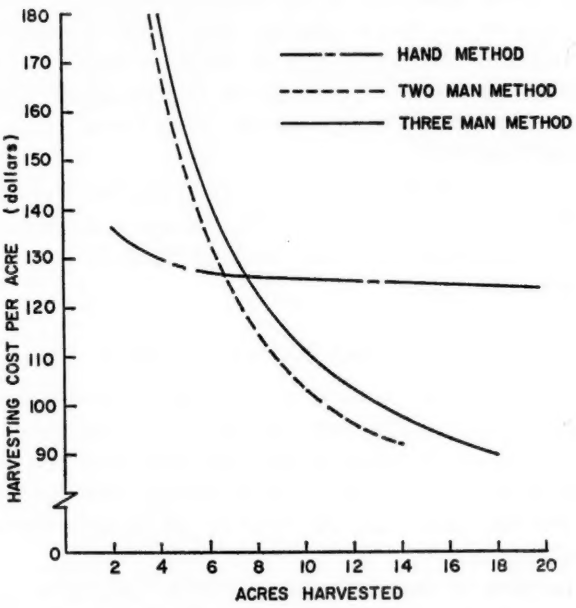

FIGURE 1. TOTAL HARVESTING COST PER ACRE FOR THE HAND METHOD AND THE TWO-ROW MACHINE.

surance. This gave an annual fixed cost of \$442.50 for the two-man method and \$467.50 for the three-man method. Fixed costs for the hand method are relatively low and were estimated at \$28 per year.[13]

The average total cost curves on a per acre basis are shown in figure 1. The two-man method becomes cheaper than hand harvesting beyond 7.5 acres, and the three-man method is cheaper than hand harvesting if over 8.3 acres are harvested per season.[14] Assuming a work week of 45 hours

[13] Chumney and Toussaint, *op. cit.*, p. 14.

[14] Tobacco is primed about once a week for six weeks. Thus, these acreages can be thought of as either per week or per season.

for harvesting and barning, the maximum number of acres one machine could handle in a season is about 10 acres for two men and about 13 acres for three men. From these estimates, it appears that this particular harvester has possibilities for reducing harvesting costs. However, to reduce costs to any extent, it will have to be used near its capacity.

From observation of the two methods, it appeared that the three-man method was somewhat easier work than when two men were used.[15] This factor appeals to farmers and may cause many farmers to use this method in preference to two men, even if costs would be slightly less with two men. Another factor favorable to the three-man method is that production per machine or per day is greater. This makes it possible to fill an average size barn in one day. With the two-man method, two days will be needed to fill an average size barn—or two machines must be used. It is desirable to fill a barn in one day so that a better job of curing the tobacco can be done.

The results of this study were presented in the form of an Extension Folder for distribution to farmers.[16] The information was available to farmers at the time that they were making their decisions concerning purchase of this harvester.

Problems and Further Evaluation

A major difficulty of this study is the determination of the productivity ranking of the workers taking part in this experiment relative to labor throughout the flue-cured tobacco area. Nothing other than a judgment that they appeared to be working at about average rates is available. This is obviously not the most desirable type of information upon which to base recommendations.

Primarily because of this difficulty, it will be desirable to check the results of this study by means of observations of farmers using the machine. Extremely abnormal wet weather in 1959 made it impossible to adequately follow up on this. Plans are to check the machines in the field in 1960.

Summary

We have presented a method by which farm machinery manufacturers and experiment stations can cooperate to evaluate machinery be-

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[15] It might be desirable in studies of this kind to evaluate the effort involved as well as production and costs. See C. W. Suggs and W. E. Splinter, "Time and Energy Analysis of Agricultural Tasks," *Transactions of the ASAE*, Vol. 1, No. 1, 1958, pp. 50-52, for a discussion of such a technique.

[16] W. D. Toussaint and D. G. Harwood, "What You Should Know About The Two-Row Tobacco Harvester," N.C. State Agr. Ext. Folder, May 1959.

fore its release. Using data from similar machines and from preliminary trials with the new machinery, estimates of potential usefulness of the machine can be made before its release. This information can then be released to farmers as a guide to them in their consideration of the worth of the machine. Such a procedure should also be beneficial to manufacturers in that they may be forewarned of a limited market for their machine.

THE ECONOMIC IMPACT OF TECHNICAL ASSISTANCE: A BRAZILIAN CASE STUDY

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TECHNICAL assistance programs have a heavy vested interest in the transfer of technology—the diffusion of ideas and methods which will increase production. Yet empirical evidence of the economic impact of such programs is limited. The present study is hopefully designed to add to the state of knowledge in this area.

The empirical work buttressing this study is based on statistical data from a selected group of farms within the state of Minas Gerais, Brazil, from 1949 through 1954. The farms and farm families for which the data are available participated in a supervised credit program under which they received a combination of credit (capital) and extension education (technology). This supervised credit program was just one phase of a broader technical assistance program of rural development called ACAR (Associacao de Credito e Assistencia Rural).[1] During the participation of the families in the supervised credit program, considerable information was gathered on farm production and home characteristics—both on their status prior to joining the program and changes through time for the duration of their participation.

The Methodology

Increased output and greater productive efficiency were taken as the two main goals of the ACAR supervised credit program. Throughout the study, these two measures are used to analyze the economic impact of the program.

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* In preparing the larger study on which the present paper is based, the author wishes to acknowledge the beneficial comments of Theodore W. Schultz, D. Gale Johnson, M. G. Reid, Carl F. Christ, H. Zvi Griliches, all of the University of Chicago; James G. Maddox, North Carolina State College; and Walter L. Crawford, Vice-President, American International Association. He is particularly indebted to Jose Paulo Ribeiro and the staff of Associacao de Credito e Assistencia Rural (ACAR) for providing the necessary materials, and to the Social Science Research Council for part of the funds necessary to conduct the analysis. Although the author is a former staff member of a sponsoring organization of the ACAR program, the views expressed herein are his own.

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[1] The ACAR program was set up in 1949 as a joint venture of the state government of Minas Gerais and the American International Association for Economic and Social Development (AIA). The latter is a non-profit corporation organized by Mr. Nelson A. Rockefeller. See Clifton R. Wharton, Jr., "Aiding the Community; A New Philosophy for Foreign Operations," *Harvard Business Review,* 32:64-72, March-April 1954. For a fuller description of the ACAR program see Arthur T. Mosher, *A Case Study of the Agricultural Program of ACAR in Brazil* (Washington, D.C.: Nat. Planning Assoc., Dec. 1955).

The change in the ratio of an output index to an input index between two time periods is frequently used to estimate relative productive efficiency or technological progress. The output index is a measure of total physical production, aggregated through the price weights of some base period. On the input side, indexes are constructed for the major factor classifications measured in either physical units or constant value terms. These indexes are then aggregated by a system of weights which represent the proportionate contributions of each input category to the total in the selected base period.

One may criticize such ratios as a measure of productive efficiency or technological progress.[2] As Ruttan points out, such a ratio is an exact measure of technological change only under rather restrictive conditions:[3] (a) The firm or industry must operate under conditions of equilibrium in the base year and subsequent periods; (b) the production function must be homogeneous of degree one (constant returns to scale); (c) prices of factors of production relative to each other and the prices of products relative to each other must remain unchanged; and (d) technological progress must be "neutral," i.e., the effect of any technological innovation must be independent of the particular combination of inputs used in the base period. If these conditions are met and if there is an increase in the ratio, this implies securing a larger output from a given input bundle than had previously been possible, indicating an improvement in technology or productive efficiency. Under this formulation, technology is viewed as increasing the efficiency of the productive process—more total output per given bundle of input resources.

Underlying all these conditions and problems in the specific case of agriculture is yield variability due to weather and other exogenous forces. Such forces often produce a fluctuating pattern of agricultural output which makes it considerably more difficult to discern the real trends in efficiency on a year to year basis for short periods.

Another possible weakness of this approach for the present study is the assumption of constant returns to scale, for under this restriction it is impossible to detect any non-technological factor which actually is giving rise to increasing or decreasing returns. All such net effects would be ascribed to technology. Criticism has been made that this is an incorrect assumption in the case of underdeveloped areas which are short on capital (implying that capital in such areas is possibly subject to increasing returns).[4] Despite evidence on the constancy of returns to scale in United

[2] For a good summary of dangers see Thomas T. Stout and Vernon W. Ruttan, "Regional Patterns of Technological Change in American Agriculture," *J. Farm Econ.*, 40:196-207, May 1958.

[3] Vernon W. Ruttan, *Technological Progress in the Meatpacking Industry, 1919-47*, U.S. Dept. Agr., Marketing Res. Rept. No. 59, Jan. 1954.

[4] This criticism was made of Professor Moore's study of technological change in

States agriculture,[5] the few pieces of research which are based on the agriculture of underdeveloped areas show varied sums of coefficients, ranging from .94 to 1.4.[6]

Although difficulties were anticipated, it was felt that this approach could provide some useful insights, provided its limitations were realized. Some attempt at the use of this technique was particularly desirable since to my knowledge it had never previously been attempted either with state data or a small sample of individual farms over time.

The Sample

Statistical data on participating farm families were gathered from two of the twenty-two ACAR local offices:

Curvelo, with a semi-subsistence agriculture near the frontier of civilization, fairly isolated from sources of new technological knowledge (here ACAR is probably the source of virtually all new ideas);

Uba, representing commercialized agriculture (tobacco and hogs) with a market orientation toward urban centers and with new technological knowledge available from several sources (ACAR source of a little over half of new technological knowledge).

In Curvelo, 82 farm families who participated in the supervised credit program for one year or more, regardless of the number of years of participation from 1949 through 1954, were selected. In Uba, 49 families who participated for two years or more were chosen.

The data from each area required stratification according to year of entry into the ACAR program. Farm families in the two samples did not participate for the same number of years nor did they all join at the same time. Observations were broken down into "classes" according to the year of entry, viz., "Class 1949," "Class 1950," etc.[7]

Mexican agriculture. Prof. James G. Maddox, "The Growth of the Mexican Economy," New York (American Universities Field Staff Letter), June 14, 1956, pp. 18-19.

[5] Earl O. Heady and Russell Shaw, "Resource Returns and Productivity Coefficients in Selected Farming Areas," *J. Farm Econ.,* 36:243-257, May 1954.

[6] All coefficients came from Cobb-Douglas production functions: Earl O. Heady and Schalk Du Toit, "Marginal Resource Productivity for Agriculture in Selected Areas of South Africa and the United States," *J. Pol. Econ.,* Dec. 1954, p. 498; Government of India, Ministry of Food and Agriculture, *Studies in Economics of Farm Management in Uttar Pradesh, Report for Year 1954-55,* under direction of G. D. Agrawal (New Delhi, Dept. of Agr., Govt. of India Press, 1957), pp. 63-65, 79-80; Government of India, Ministry of Food and Agriculture, *Studies in Economics of Farm Management in Madras, Report for Year 1954-1955,* under direction of C. W. B. Zacharias (New Delhi: Dept. of Agr., Govt. of India Press, 1957), pp. 132-133.

[7] For a detailed description of the data collection methods, processing procedures, and techniques of estimation used in the construction of the final indexes see Clifton R. Wharton, Jr., "Processing Underdeveloped Data from an Underdeveloped Area," *J. Amer. Stat. Assoc.,* March 1960.

General characteristics of the sample—the "before"[8]

The farm characteristics of the average Curvelo farm when it joined the ACAR program conform fairly well with those for the state; those for Uba were generally higher (Table 1). In both Curvelo and Uba, the average amount of cropland is virtually the same as the state average (11 hectares or about 27 acres); in Curvelo, pasture is somewhat larger than the state average, in Uba, lower, reflecting differing methods of cultivation. (A rotational pattern of farming—burning, clearing, planting for a few years, and returning to second growth—is quite common in Curvelo). Land values in Curvelo are generally lower, which conforms with casual observation of the land and with guesses as to its productivity; values in Uba are higher, reflecting the higher proportion of cropland. The value of buildings reported for the ACAR farms excludes houses, which are included in the state averages. Cash operating expenses are about 40 per cent lower in Curvelo than the state average, reflecting in part the subsistence character of the production process in this semi-frontier region; those in Uba are almost two and a half times higher than the state average, again conforming with the expected degree of commercialization in this area.

The average farm and home characteristics in the Curvelo and Uba samples before joining the program present interesting contrasts between subsistence and commercial agriculture. In Uba, about 71 per cent of the value of total output was sold, in Curvelo only 55 per cent. Much of the unsold output represented home consumption and the rest was mainly share-cropping payments (for land or labor). The average value of gross sales in Uba was about Cr$ 48,900 or a little less than US$ 1,000; in Curvelo, Cr$ 17,200 or US$ 344. (During most of this period US$ 1 = Cr$ 50.)

The total yearly labor in Curvelo averaged 39 man months per crop year per farm; in Uba, 44 man months. But in Curvelo family labor

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The individual farm data collected consisted of the four basic records which are maintained regularly by the ACAR technicians: (a) the farm plan which serves as the basis for the granting of a loan and which records farm production and expenditures for the period prior to the current loan application, stipulates the new practices to be adopted during the following year, indicates the farm inputs (except family labor) to be used during the coming year, and lists anticipated expenditures, output, income, and use of the loan funds; (b) a home plan which describes certain characteristics of the home and family (members' age, sex, and level of education) and outlines improved practices which will be followed; (c) a family progress report form which summarizes the yearly changes in certain measures of farm and home life such as net worth, size of farm, farm equipment, farm buildings, sewing machines, kitchen equipment, etc.; and (d) a written report summarizing each visit by the technicians to the farm or family.

[8] The statistical data on which the information in this section is based will be found in Clifton R. Wharton, Jr., "A Case Study of the Economic Impact of Technical Assistance" (unpub. Ph.D. diss., Dept. of Econ., Univ. of Chicago, 1958) pp. 63-70.

TABLE 1. SELECTED COMPARISONS OF CHARACTERISTICS OF MINAS GERAIS FARMS WITH ACAR FARMS IN CURVELO AND UBA AT TIME OF JOINING THE PROGRAM (AVERAGES PER FARM)

Item	Minas Gerais[a]	ACAR Farms[b]	
		Curvelo[c]	Uba
No. of Observations	265,497	77	49
Land (Has.)[d]			
Crop	11.1	11.2	10.9
Pasture	86.3	99.0	20.2
Total	97.4	110.2	31.1
Assets (Cr. $)			
Land (Owned)	75,889	49,072	90,224
Buildings[e]	10,415	2,860	12,026
Farm Equipment and Work Animals	7,814	12,368	11,432
Cash Operating Expenses (Cr. $)[f]	4,196	2,498	10,199
Tenure (Per cent)			
Owner	88	74	51
Part-Owner	—	8	18
Renter	3	18	31
Other	8	—	—
Age of Farmer (Years)[g]	—	39.4	35.4
Education (Years)[h]	—	1.9	2.4

[a] Minas Gerais averages computed from Instituto Brasileiro de Geografia e Estatistica, Conselho Nacional de Estatistica, *Anuario Estatistico do Brasil 1956*, (Rio de Janeiro: Servico Grafico do IBGE, 1957) pp. 96, 98, 99, 100 (data from 1950 census).

[b] Averages for ACAR farms in Curvelo and Uba ignore class groupings. Therefore the data are for different crop years and some of the cruzeiro figures are inflated.

[c] Curvelo data excluded Class 1953.

[d] Cropland and pasture land only. (1 hectare=2.47 acres).

[e] Values of homes are excluded in ACAR farms, but included in Minas Gerais.

[f] Does not include salaries of hired labor—only expenses for such items as seeds, insecticides, fungicides, rent, taxes, etc.

[g] Based on 57 reporting age in Curvelo, all 49 in Uba.

[h] Education is based only on those reporting—41 in Curvelo, 21 in Uba.

accounted for about 68 per cent of the total labor, while in Uba it was nearly 50 per cent. Shares accounted for about 10 per cent of the total labor in Curvelo, but only 4 per cent in Uba.

The typical or average Curvelo farm family joining the program can be pictured as follows: The father in his late thirties with about two years of primary schooling, a wife about the same age, one son or daughter about thirteen, three or four other children, and usually a baby under one year. They lived in an eight room house with a dirt floor; slept on four beds (one double). They had no electricity, sanitary privy, or running water. Such a family of six consumed about four and one half pigs a year, about a chicken a week, and a little over a dozen eggs a week. They also consumed almost half their yearly manioc production, and about one-third the farm production of corn, beans and rice. The farmer owned his own land, sold about half of all the farm output he produced, but paid out some of the unsold output as shares for needed labor during harvest and planting.

The typical or average Uba farm family joining the program would also consist of six persons with about the same age distribution. They would live in a somewhat better home than their counterpart in Curvelo. The farmer would own part of his land and probably rent some additional acreage. He would be heavily dependent upon tobacco and corn, which would account for two-thirds of all production. He would sell almost three-fourths of his total production—tobacco as his main cash crop. The rest would mainly be consumed by the family, largely pork, chickens, milk, eggs, beans, rice and manioc.

Upon joining the program the typical farmer secured a first year loan which averaged Cr$ 20,000 in Uba and Cr$ 10,700 in Curvelo. The Uba farmer divided his loan 54 per cent for capital purchases and 46 per cent for cash operating expenses—largely labor and fertilizer. The Curvelo farmer divided his loan 67 per cent for capital purchases and 33 per cent for cash operating expenses. Very little of these amounts went for home items (in Curvelo less than 2 per cent).

The approach to evaluation—the "after"

The evaluation of the ACAR program's impact on output and productive efficiency required the preparation of indexes of yearly output and yearly input on an individual class basis. Briefly, the yearly output index for each class was the sum of individual farm outputs valued by base year prices, and the yearly input index for each class was the sum of individual farm inputs aggregated through a weighting process.[9]

The various indexes for individual input categories to which the percentage weights are applied are in *real* terms, i.e., the index of yearly change for any factor input which is measured in cruzeiros has been de-

[9] The weighting process for inputs determines the proportionate contribution of each input to the productive process. Base year percentage weights for each class were prepared for each major input category.

(a) Land—12.5 per cent interest on the value of land in the base year (since classes were not added, it was not necessary to deflate the base year value figures); (b) Labor—the cruzeiro expenditure in the base year (cash expenditure on hired labor, an imputation for family labor, and the value of certain share payments); (c) Cash Operating Expenditures—the cruzeiro value of expenditures in the base year (excluding cash payments for hired labor); (d) Buildings—5 per cent depreciation plus 12.5 per cent interest on the value of farm buildings in the base year (excluding the home); (e) Farm Equipment—15 per cent depreciation plus 12.5 per cent interest on the value of farm equipment in the base year; (f) Work Animals—12.5 per cent interest plus 10 per cent depreciation on the value of work animal stocks in the base year; (g) Productive Animals—12.5 per cent interest on the value of the stock in the base year (since productive animal output includes net changes in stock, no depreciation is taken).

The interest rate of 12.5 per cent is an estimate of the real rate of return on capital in Brazilian agriculture. See Wharton, "A Case Study of the Economic Impact . . . ," *op. cit.*, pp. 33-41.

flated. Consequently, it must be emphasized that the interest and depreciation rates which are used in the construction of the base year percentage weights need not take account of the Brazilian inflation.[10]

The problem of base year error

Since the base year for every class is the year before the farms joined the ACAR program, there is a natural tendency for error to occur in the reporting of the base year data—especially output. Technicians are unfamiliar with a new family, and in most instances have had no prior contact with them during the preceding crop year; thus they must rely upon the farmer's memory of his expenditures, crop yields, etc. Sometimes a farmer fears revealing such data because the technician may be suspected of being a tax collector; at other times, the farmer may be ashamed of a particular feature of his operation and exaggerate. In general, the net bias from these sources is on the under-reporting side. Moreover, even with a correct output report, there is the problem of whether the base year was atypical—was there a drought, a bumper crop, etc.? These possibilities are of importance in utilizing output/input indexes, since one essential condition for use of such estimates is that the firm must operate under conditions of equilibrium in the base year.

The correction procedure chosen was to use the value of total base year inputs (cruzeiro flow, not stocks) as the new base year output. The input flow substituted for output corresponds to the flow derived in the construction of the weights used to prepare the input indexes. Yearly input flows are relatively more stable than output in agriculture, since most factor inputs are committed at the beginning of the crop year and can not be easily reduced or varied if adverse weather or prices later develop. The rigidity of input factor commitment is especially strong in underdeveloped areas where family, labor, and land represent such a heavy proportion of the total. From a theoretical viewpoint, such a correction proceeds on the assumption that base year inputs flows represent the long-run equilibrium flow of both inputs and outputs under conditions of constant returns to scale.

Indexes for the State of Minas Gerais and for Brazil

Entirely new agricultural output and input indexes for the state of Minas Gerais and for Brazil as a whole were prepared for the period 1944

[10] From 1939-54 the Brazilian agricultural price index was rising at a rate of 15.6 per cent per year (geometric). Computed from price indexes published in United Nations, Economic Commission for Latin America, *Analysis and Projections of Economic Development, II. The Economic Development of Brazil,* New York 1956, pp. 70, 76.

through 1955 to make comparison tests with the ACAR indexes.[11] To my knowledge no previous output or input indexes are available for the individual state of Minas Gerais. The only previous input indexes and output/input indexes for Brazilian agriculture were constructed by Professor Clarence A. Moore.[12]

Although there are several series estimating the total yearly output of Brazilian agriculture, an entirely new series was prepared, for two reasons: (a) the desire to follow identical index number construction procedures both with the ACAR farm data and with the national and state data, for sake of comparability; and (b) the need to determine how large the error might be that is introduced into the national and state indexes when using the index number construction procedures followed with the ACAR farm data. (No large errors seemed to be introduced.)

The new indexes for agricultural output revealed a growth rate of 3.73 per cent per year for Brazil as a whole and 2.63 per cent per year for Minas Gerais. The growth rates in the corresponding output/input indexes were: Brazil, 1.64 per cent per year, Minas Gerais, 1.55 per cent per year.

The index of aggregate output for the ACAR farms in Curvelo (all classes combined) reveals a startling growth rate, between 21 and 32 per cent per year, and a growth rate in productive efficiency between 7 and 16 per cent per year (Table 2). In Uba, however, the combined growth rate in aggregate output lay between 7 and 11 per cent per year, while productive efficiency decreased at a rate between 3 and 7 per cent per year.

These estimates for the ACAR farms should be compared with those for the state of Minas Gerais, which in the period from 1944 through 1955 was experiencing a 2.6 per cent per year growth rate in agricultural output and a 1.6 per cent growth in efficiency. In the period covered by the study, 1948 through 1954, output for the state was experiencing almost no growth and efficiency was declining.

Output Indexes: All the Curvelo indexes of output show marked rates of growth. There is some variability among Curvelo classes, but the range is not as wide as in Uba; in Curvelo, the range in growth rates of output among the classes is from 23 to 40 per cent per year for the uncorrected indexes and 16 to 25 per cent per year for the corrected indexes. The in-

[11] Two different sets of estimates were prepared; one set covering the period 1940-1955 using 1940 price weights, a second set covering the period 1944-1955 using 1950 price weights. See Clifton R. Wharton, Jr., "Recent Trends of Output and Efficiency in the Agricultural Production of Brazil, Minas Gerais and São Paulo," *Inter-American Economic Affairs,* Vol. 13, No. 2 (1959), pp. 60-88.

[12] C. A. Moore, "Recent Developments in Brazilian Agriculture," *J. Pol. Econ.,* Aug. 1956, pp. 341-366.

TABLE 2. RATES OF GROWTH IN INDEXES OF AGRICULTURAL OUTPUT AND OF OUTPUT/INPUT, BRAZIL,[a] MINAS GERAIS,[a] AND ACAR CLASSES IN CURVELO AND UBA[b]

Index, Area, and Period or Class	Rate of Growth in—			
	Output		Output/Input	
	(Per cent per year, geometric average)			
Output				
Brazil, 1944–55	3.73		1.64	
Minas Gerais, 1944–55	2.63		1.55	
Minas Gerais, 1948–54	−.25		−1.74	
Curvelo: Class of—	Corrected[c]	Uncorrected	Corrected[c]	Uncorrected
1949	25.0	23.1	12.0	10.1
1950	21.4	39.7	2.4	17.8
1951	23.8	33.3	8.3	16.6
1952	15.7	25.8	9.2	18.7
All Classes[d]	21.0	32.0	7.0	16.0
Uba: Class of—				
1949	12.2	−.1	−2.2	−12.9
1950	7.5	−.3	−.8	−8.0
1951	18.1	21.6	−6.4	−4.7
1952	3.3	13.1	−1.0	8.4
All Classes[d]	11.3	7.1	−2.7	−6.7

[a] Computed from series in C. R. Wharton, "Recent Trends of Output and Efficiency in the Agricultural Production of Brazil, Minas Gerais, and São Paulo," *Inter-American Economic Affairs*, Vol. 13, No. 2 (1959), pp. 60–88.
[b] Computed from class indexes in C. R. Wharton, "A Case Study of the Economic Impact . . . ," *op. cit.*, pp. 79, 84.
[c] See text, "The problem of base year error."
[d] Computed by weighting growth rate of each class by number of yearly observations reported.

teresting aspect of the results is the apparent failure of droughts to affect the results in Curvelo, while they do seem to have hit Uba. According to available evidence, the entire period covered by the study was a poor one climatically for agriculture. In Curvelo, serious droughts occurred in 1950-51, 1951-52, and a most severe one in 1953-54. In Uba, the period was also characterized by bad weather with a very severe drought in 1950-51.

Input Indexes: Growth rates on the input side in Curvelo tend to be less varied than those for Uba, even though the average rate of growth is virtually the same in both, 14.4 per cent in Curvelo compared with 14.5 per cent in Uba.[13] In both Curvelo and Uba the largest increases in the major input categories came in "cash operating expenses" and "farm buildings, equipment, and work animals." In Curvelo there were also large increases in "productive animals." While there were increases in "land" and "labor," in most classes these increases did not approach the sizeable ones in the other categories.

[13] Wharton, "A Case Study of the Economic Impact . . . ," *op. cit.*, p. 82.

The test

The most obvious null hypothesis to apply to estimates showing changes in the output and productive efficiency of the ACAR farms is that the changes are in fact no different from what was generally occurring to other farms in the state of Minas Gerais. The statistical procedure chosen to judge this was to test the significance of the difference between the trends (slope coefficients from simple linear regressions against time) of each class and average trends for the state.[14] (The general farming characteristics of the sample of ACAR farms were, as shown in Table 1, about the same as the averages for farms in the state.) The alternative hypothesis is that the changes experienced by the ACAR farms in output and productive efficiency are *not* the same as those experienced generally in the state. If the ACAR farms have in fact experienced greater positive changes in output and productive efficiency, the implication of the latter hypothesis is that the ACAR program is the reason for the difference, since ACAR participation is a common characteristic of the sample.

Output

Simple linear regressions of output indexes on time were calculated for each class in Uba and Curvelo (Table 3) using both the uncorrected and the corrected indexes.

When the Curvelo trends in output are tested against the general trends for the state and Brazil, the results show up quite satisfactorily despite the extremely low degrees of freedom and the large standard errors (Table 4). Compared with the Minas Gerais 1948-54 series, all Curvelo classes except the corrected Class 1951 were significantly different at least at the 10 per cent level. The same was true when compared with the ten-year trend for the state or even for Brazil as a whole from 1944 through 1955. Even for the 1951 Class, the level was only slightly higher.

Note that during the period covered by the study, the agricultural output of the Minas Gerais was experiencing no growth, resulting in a slope

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[14] This procedure assumes that you have two statistically independent slope estimates b and you wish to test the hypothesis that $Eb_i = Eb_j$. The variance of the observations around the regressions in both populations is assumed to be the same and a pooled estimate of the variance is found by

$$s^2_{(b_i-b_j)} = s^2_{b_i} + s^2_{b}.$$

A *t*-test is then applied to the difference as follows:

$$t(N_1 + N_2 - 4) = \frac{b_i - b_j}{s_{(b_i-b_j)}}$$

TABLE 3. SUMMARY OF SIMPLE REGRESSIONS OF AGGREGATE AGRICULTURAL OUTPUT INDEXES ON TIME, FOR BRAZIL, MINAS GERAIS, AND ACAR CLASSES IN CURVELO AND UBA[a]

Area and Period or Class	b_i	s_{b_i}	t_{b_i}	Per Cent Level of Significance for b_i
Brazil, 1944–55	3.89	.10	38.81	1.0
Minas Gerais, 1944–55	1.66	.33	5.02	1.0
Minas Gerais, 1948–54	− .006	.96	.006	50.0[b]
Curvelo				
Uncorrected				
1949	33.30	3.33	9.99	1.0
1950	49.82	17.88	2.79	5.4
1951	43.34	10.53	4.11	2.7
1952	29.13	10.71	2.72	11.3
Corrected[c]				
1949	36.61	8.05	4.55	2.2
1950	25.06	11.83	2.12	8.5
1951	36.21	28.90	1.25	16.2
1952	16.92	9.18	1.84	16.1
Uba				
Uncorrected				
1949	2.32	6.85	.34	39.0
1950	− .84	3.82	.22	42.7
1951	23.53	7.68	3.06	4.5
1952	14.00	12.82	1.09	23.5
Corrected[c]				
1949	13.45	13.02	1.03	18.7
1950	5.03	4.82	1.04	19.6
1951	18.26	10.54	1.73	11.6
1952	3.36	10.87	.31	40.7

[a] The form of the regression is $I=\alpha+\beta T$, where I=index and T=year or time period. The indexes for Brazil and Minas Gerais for 1944–55 were converted to three-year moving averages, that for Minas Gerais in 1948–54 was not. For the original indexes, see Wharton, "Recent Trends of Output and Efficiency . . . ," *op. cit.*, pp. 60–88.
[b] The slope coefficient (b_i) for this regression is not significantly different from zero.
[c] See text, "The problem of base year error."

coefficient which does not differ significantly from zero.

Uba did not fare as well. Only the Class 1951 showed up as significantly different at the ten per cent level from Minas Gerais 1948-54 and Minas Gerais and Brazil, 1944-55. All the others were not significantly different from the trends of the state or Brazil. This was true for both the corrected and uncorrected output series.

In all cases where differences were significant they indicated higher trends of output for the ACAR groups.

Efficiency

Simple linear regressions of output/input indexes on time were likewise calculated for each class in Uba and Curvelo (Table 5).

When the Curvelo slopes of output/input indexes are tested against the general trends, the results are somewhat less impressive than the output test results (Table 6). Against Minas Gerais 1948-54, all the uncorrected

TABLE 4. SIGNIFICANCE LEVELS[a] OF DIFFERENCES BETWEEN TRENDS OF AGRICULTURAL OUTPUT INDEXES OF THE ACAR FARMS AND TRENDS OF AGRICULTURAL OUTPUT INDEXES OF MINAS GERAIS AND BRAZIL

Area and Class	Probability Levels at Which ACAR Farm Trends Are Significantly Different from Trends for—		
	Minas Gerais, 1948–54	Minas Gerais, 1944–55	Brazil, 1944–55
		Per cent	
Curvelo			
Uncorrected			
1949	1	1	1
1950	5	5	5
1951	1	1	1
1952	5	5	5
Corrected			
1949	1	1	1
1950	5	5	10
1951	b	b	b
1952	10	10	10
Uba			
Uncorrected			
1949	b	b	b
1950	b	b	b
1951	1	1	5
1952	b	b	b
Corrected			
1949	b	b	b
1950	b	b	b
1951	10	10	10
1952	b	b	b

[a] For test procedure see text and text footnote 14.
[b] Difference not significant at 10 per cent level.

output/input indexes are significant at least at the 10 per cent level, and all the corrected, except 1950, are significantly different. (During the period covered by the study, the productive efficiency of Minas Gerais was declining.) But when Curvelo is tested against the state and Brazil for the longer period 1944 through 1955, somewhat more variability enters. With the uncorrected figures, Class 1950 is not significantly different from either the state or Brazil at the 10 per cent level. With the corrected figures, Classes 1950 and 1952 are not significant. But again the significant differences all show progress in Curvelo.

None of the Uba classes showed up at the 10 per cent level as significantly different from the trends in productive efficiency of the state during this period, using either the corrected or uncorrected output/input indexes. In most cases, the Uba slopes were negative. When these negative slopes are tested against the positive slopes in the state and Brazil for the longer period, 1944-1955, a few of the corrected and uncorrected classes show up as significantly different, but in the "wrong"

TABLE 5. SUMMARY OF SIMPLE REGRESSIONS OF AGGREGATE AGRICULTURAL OUTPUT/INPUT INDEXES ON TIME, FOR BRAZIL, MINAS GERAIS AND ACAR CLASSES IN CURVELO AND UBA[a]

Area and Period or Class	b_i	s_{b_i}	t_{b_i}	Per cent Level of Significance for b_i
Brazil, 1944–55	1.42	.09	15.39	1.0
Minas Gerais, 1944–55	.23	.31	.75	22.3
Minas Gerais, 1948–54	− 1.45	.89	1.63	8.5
Curvelo				
Uncorrected				
1949	12.82	5.61	2.29	7.4
1950	16.04	14.30	1.12	19.3
1951	16.61	7.37	2.25	7.4
1952	20.50	8.95	2.29	13.0
Corrected[b]				
1949	14.63	2.07	7.07	1.0
1950	1.97	3.15	.62	30.5
1951	12.79	8.05	1.59	12.5
1952	9.62	7.32	1.31	20.9
Uba				
Uncorrected				
1949	− 7.80	4.90	1.59	9.2
1950	− 6.57	3.99	1.65	9.4
1951	− 3.44	3.33	1.03	19.6
1952	8.82	9.23	.96	25.0
Corrected[b]				
1949	2.61	12.15	.21	42.6
1950	− 2.60	3.84	.68	26.7
1951	− 3.16	.86	3.67	3.3
1952	− .97	7.83	.12	46.8

[a] The form of the regression is $I=\alpha+\beta T$, where I=index and T=year or time period. The indexes for Brazil and Minas Gerais for 1944–55 were converted to three-year moving averages, that for Minas Gerais in 1948–54 was not. For the original indexes see Wharton, "Recent Trends of Output and Efficiency . . . ," *op. cit.*, pp. 60–88.

[b] See text "The problem of base year error."

direction, i.e., the short-run trends were significantly lower or "worse" than the long-run trends for the state and Brazil.

Summary and Conclusions

An important *caveat* must be made before proceeding to any conclusions. A most serious reservation about the entire study concerns the reliability of the data—national, state, and farm. Misgivings are particularly felt with the individual farm data where sampling variability was great. Moreover, experience with the individual data leaves the suspicion of similar variability and possible sources of error underlying the state and national statistics.

The economic investigator is bound to consider the present results with healthy suspicion in view of the basic crudity of the data and the well-known difficulties of collecting and processing data from underdeveloped areas. Such difficulties are especially frustrating when dealing with individual farm data. In the case of ACAR, greater faith may be justified compared with similar data secured from a farm survey, if only because the ACAR technicians maintained the records on a regular basis and

TABLE 6. SIGNIFICANCE LEVELS[a] OF DIFFERENCES BETWEEN TRENDS OF AGRICULTURAL OUTPUT/INPUT INDEXES OF THE ACAR FARMS AND TRENDS OF AGRICULTURAL OUTPUT/INPUT INDEXES OF MINAS GERAIS AND BRAZIL

Area and Class	Probability Levels at Which ACAR Farm Trends Are Significantly Different from Trends for—		
	Minas Gerais, 1948–54	Minas Gerais, 1944–55	Brazil, 1944–55
		Per cent	
Curvelo			
Uncorrected:			
1949	5	5	5
1950	10	b	b
1951	5	5	5
1952	5	5	5
Corrected:			
1949	1	1	1
1950	b	b	b
1951	10	10	10
1952	10	b	b
Uba			
Uncorrected:			
1949	b	(10)	b
1950	b	(10)	(10)
1951	b	b	(5)
1952	b	b	b
Corrected:			
1949	b	b	b
1950	b	b	b
1951	b	(1)	(1)
1952	b	b	b

[a] For test procedure see text and text footnote 14. Significance levels in parentheses indicate that the class is different in the "wrong" direction, i.e. the class trend is worse than that of the state or of Brazil.

[b] Difference not significant at 10 per cent level.

were in frequent contact with the families throughout the crop year of participation. Moreover, many decisions were made in the construction of indexes which were adverse to the showing of positive rises in the output and output/input indexes. Particularly, the heavy interest rates and depreciation rates, and the impossibility of deflating certain capital inputs, although they were unavoidable recourses, were adverse to the showing of any positive change from participation in the ACAR program of supervised credit.

The fascinating feature of the results is the contrast between Curvelo and Uba. The dramatic changes in Curvelo can not be denied, even accepting the limitations of the data. The ACAR program did have a decided positive effect on the agricultural production and productive efficiency of the Curvelo farms. In Uba, on the other hand, the results fail to differentiate the trends of output and productive efficiency from those which were taking place in the state as a whole, implying that the ACAR program had had no effect.

The primary characteristic which distinguishes the farms studied from

those in the rest of the state is participation in the ACAR program. Regional differences certainly exist, but the measurable characteristics of most ACAR classes in both areas—but especially in Curvelo—do not diverge greatly from those of the state. Thus the presumption can be made that the ACAR program was partly responsible for the observed changes in output and productive efficiency. The most dramatic aspect of the Curvelo results is that the positive changes in output and productive efficiency took place despite adverse agricultural weather.

Certain facts may help to explain the contrast between Curvelo and Uba.

(1) Crop/livestock output ratio. Part of the explanation may lie in the difference between the two areas in their ratios of crops to animal and animal-product output. In Curvelo, crops represent 63 per cent of the value of total output; in Uba, 85 per cent. A heavier concentration on crops frequently implies a heavier dependence upon rainfall, unless irrigation is available.

(2) Diversification of output vs. monoculture. In Uba, tobacco and corn account for two-thirds of the value of all output. In Curvelo, corn, rice, and sugar cane account for 50 per cent, and pigs and cattle account for another 27 per cent. Curvelo thus has a greater diversification in its output and a greater dispersion in the relative weights of various crop and animal items compared to Uba. The heavy concentration of Uba on tobacco, and therefore a particularly heavy dependence on rainfall, could have proven to be a severe detrimental factor.

(3) Technology and isolation. Another possible explanation may be that Curvelo offered greater opportunity for benefit from technological improvement. If we look upon technology as we would any standard factor input, certain interesting conclusions emerge. All evidence indicates that Curvelo, compared with Uba, was relatively much more isolated from sources of new technology—that is, the "supply" of technology (flow per unit of time) was relatively less in Curvelo. Further, observation of the level of farm management and practice in a frontier or isolated region like Curvelo would lead to the judgement that the absolute level of "supply" (stock) of technological input in Curvelo was also relatively low. In some cases, these two characteristics of the supply of "factor" technology could create situations where the introduction of new technology gives rise to increasing returns in the productive process.

The Uba families had not been cut off from new technology before joining the program and did not suffer from any appreciable "shortage" of new technology. In Curvelo, on the other hand, new technology was in short supply and any technological introductions gave rise to notable changes in output and productive efficiency. If this inference is correct,

then the support which the ACAR program has received from so many quarters in the state (and in Brazil) is understandable, because more of the original offices which ACAR operated were closer to the Curvelo than the Uba pattern.

The present study is the outgrowth of an evaluative system which was meshed with the operating routine of a technical assistance program. Although it had been designed primarily for internal administration, it offered an excellent opportunity to assess one phase of a technical assistance program.

The need for sound approaches to the evaluation of technical assistance and economic development programs is urgent. The crucial importance of evaluation can be readily appreciated when one realizes the magnitude of the overseas economic development efforts which are being carried on by the non-profit sectors of our economy—public and private. In the last decade, the United States alone has spent more than $50 billion on overseas aid programs. This is the magnitude of development programs carried on without *any* automatic signals which will tell the good job from the bad, the good choice from the bad.

Of course, this problem is not unique to technical assistance or economic development; it is an inherent characteristic of any non-profit venture which is not subject to the rewards and punishments of the price system. We hope that the present study will serve as one example of how such evaluation can take place.

SOUTHERN FOREST-PRODUCTS AND FORESTRY: DEVELOPMENTS AND PROSPECTS

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I

THE Southern region, which is usually thought of as predominantly a row-crop and livestock-producing area, also contains about two-fifths (193 million acres) of the nation's commercial forestlands. In 1954, wood from these forests provided the basic raw material for more than a third of the region's near-60,000 manufacturing establishments, despite the fact that the "forest-products industries" classification was defined in such a way as to exclude timber growing and/or logging businesses, as well as printing and publishing firms.[1] More recent figures show that the forest-products industries accounted for nearly a sixth of the region's 1956 manufacturing employment and for an eighth of all dollar payrolls and value-added. A third of the nation's forest-products workers were employed in the South, and the region's forest-products dollar payrolls and value-added each made up more than a fourth of the aggregates for the country as a whole (see Table 1).

Growth potential is an important consideration, also, particularly when a region is faced with a paucity of capital and a wealth of unskilled laborers. Since timber is the only non-agricultural extractive resource which can be replenished or expanded in quantity, it is not unreasonable to expect that forestry and forest-products will assume a more important role in the South's future, especially given the likelihood of a continued decline in general agriculture and rapid exhaustion of other extractive resources. It is entirely possible, as one observer has predicted, that the South's "greatest and greenest" promise for the future lies in her forests.[2]

In the present study, we shall survey the major shifts which are taking place in the relative positions of the important forest-products industries, as well as the prospects for the future of each industry. Related changes in the management of forest resources must be examined, also, since these stem from, and contribute to, changes in the use to which the forest is put. Finally, after having defined the forest-product industry in which

[1] Lumber and Wood Products establishments were most numerous (18,501), followed by Furniture and Fixtures (2,515), and Pulp, Paper and Products (691). See *1954 Census of Manufactures* (Dept. of Commerce, Wash., D.C.), Vol. II, Part 1, Table 6B, p. 73.

[2] Jonathan Daniels, *The Forest is the Future* (International Paper Co., New York: 1957).

most of the future growth seems destined to occur (pulp and paper), we shall turn to an analysis of the developments most likely to hinder such growth, assessing the need for public policy. Since most of the business firms and employees of the forest-products industries presently are employed in lumber production, it is appropriate to begin with this industry.

II

Large-scale lumbering operations began in the South in the 1890's and reached a peak in 1909, in which year an output of nearly 20 billion board feet of lumber (80 per cent Southern pine) made up 45 per cent of

TABLE 1. ECONOMIC IMPORTANCE OF THE SOUTH'S FOREST-PRODUCTS INDUSTRIES, 1956

Industry Group	Employees	Payrolls	Value Added by Manufacturing
	Thousands	*Thousand dollars*	
Lumber and Wood Products	293.7	662,970	1,088,207
Furniture and Fixtures	121.5	384,504	663,483
Pulp, Paper and Products	130.7	593,983	1,441,091
Southern Forest Products	546.0	1,641,457	3,192,781
All Southern Mfg. Industry	3,509.5	13,003,459	26,457,798
	Per cent	*Per cent*	*Per cent*
Forest Products as Per Cent of All Southern Mfg. Industry	15.6	12.6	12.1
Southern Forest Products as Per Cent of U. S. Forest Products Industry	33.3	26.0	27.5

Source: Compiled from U. S. Dept. of Commerce, *Annual Survey of Manufactures: 1956* (U. S. Gov't Print. Off., Washington, D. C.: 1958), Table 3, pp. 48, 52, and 54. Individual state data are not always available, hence the "South" includes Delaware, Maryland, West Virginia, Kentucky, and the District of Columbia. Totals may not equal sums of columns, due to rounding.

the nation's domestic supply. Production declined slightly thereafter, but held up fairly well until the mid-1920's, when the downward swing of the building cycle caused a drop to 15.5 billion (with pine down to 12 billion) board feet. A precipitous fall in output occurred in the early years of the Great Depression, somewhat more pronounced than in other regions of the country.

Recovery from the depression was slow, and it was not until early wartime demands for lumber made themselves felt that output again climbed to near-1929 levels. In the late war years production again fell off, and a brief resurgence in the immediate post-war period failed to hold up, so that output fell to about 12 billion board feet in 1949. Since that time, Southern lumber output has declined steadily; in the years 1950-1953, for

example, in the face of the greatest building "boom" in the history of this country, lumber output of Southern mills dropped by 20 per cent, while Southern pine volume fell even more, by 25 per cent. And, in the years 1947-1954, employment in sawmills and planing mills fell from 207,000 in the former year to 154,000 in the latter year, or by about 25 per cent. In 1958, lumber production reached a low unmatched during this century in any year except at the depth of the depression of the 1930's. Southern pine was not even able to claim this qualification.[3]

Reasons for an overall decline are readily apparent. Per capita lumber consumption in residential building has slumped badly,[4] while the use of substitutes has mushroomed. Changes in the architectural styling and size of houses have been important, as have improvements in the quality of, and discovery of new uses for, non-fibrous materials such as glass, brick, steel, aluminum, concrete and tile, and fibrous materials such as paperboard, laminated panels, pressed-wood, and some plastics. Markets in which lumber once reigned supreme have been lost; particular instances which come readily to mind are the container market, almost completely preempted by paperboard in recent years; the roofing market, 70 per cent of which has been lost to asphalt shingles and other materials;[5] and the window market, half of which has been lost to steel and aluminum. Aluminum, brick, and steel have made serious inroads into the siding market, even where low-cost housing and farm buildings are concerned.

While it may be true that ". . . there has been no marked trend in lumber production in the South since 1940,"[6] the nature of the problem is obscured by the choice of time-period and by failure to break total output down into components. If 1925 and 1958 figures are compared, the data show that while hardwood lumber output did not change at all, softwood lumber production dropped by 56 per cent. In the postwar period

[3] Data on lumber output, historic and recent, from *The Demand and Price Situation in Forest Products* (U.S. Forest Serv., Wash., D.C., Nov. 1958), p. 25, as revised by data furnished by Div. of Forest Economics Research, Sept. 11, 1959. Data on employment from *1954 Census of Manufactures* (U.S. Dept. of Commerce, Wash., D.C., Dec. 1956), Ser. MC-24, pp. 3-4.

[4] According to the Forest Service, per capita lumber consumption fell from 539 bd. ft. in 1900 to less than half that amount, or 248 bd. ft., in 1955. *Timber Resources for America's Future* (Wash. D.C.: Jan. 1958), p. 12. In residential construction, dwelling units which contained 18,900 bd. ft. of lumber in 1920, on the average, contained only about 10,500 bd. ft. in 1953. Stanford Research Institute, *America's Demand for Wood: 1929-1975* (Weyerhaeuser Timber Co., Tacoma, Wash.: 1954), p. 35. By 1975, the Forest Service predicts, dwelling units will contain only about 7,500 bd. ft. of lumber, on the average. *Timber Resource Review* (Wash., D.C.: Sept. 1955), Chap. VI, p. 59.

[5] Julian H. Zimmerman, FHA Commissioner, Speech before the Natl. Lumber Mfrs. Assn. (Wash., D.C., Nov. 20, 1959).

[6] *The Demand and Price Situation for Forest Products, op. cit.*, p. 4.

1946-1958, Southern softwood (chiefly pine) lumber production has fallen by an average of about 244 million board feet per year.[7]

Southern Pine lumber's difficulties, moreover, cannot be attributed solely to a reduced general demand for wood, since not all woods have encountered the problem. Douglas-fir sales, for example, have increased rapidly in recent years (65 per cent during 1945-1954), not only in other parts of the country, but also in the South. As a fairly recent study points out, fir has found it possible to invade the Southern pine "home market" despite freight charges equal to as much as fifty per cent of the f.o.b. mill price of fir.[8] Price differentials or changes cannot be blamed for the shift in demand,[9] and the only other explanation which seems reasonable is that pine quality has deteriorated badly as low-volume ("peckerwood") sawmills, in particular, have had to rely upon the "pitchy," small-dimensioned, wide-ringed, second-growth for an increased proportion of their raw material inputs. Improper seasoning may be a second, though less important, factor. It is significant that many Southern lumberyards have ceased to stock Southern pine entirely, complaining chiefly of quality.

TABLE 2. ANNUAL WOODPULPING CAPACITY OF U. S. MILLS, BY REGIONS, SELECTED YEARS, 1934–1957

Year	Pacific Coast	Lake States	New England	Middle Atlantic	South	United States	South as Per Cent of U. S.
				Thousand short tons			
1934	1,296	1,364	1,490	981	1,214	6,345	19.1
1939	1,659	1,491	1,096	1,096	3,399	8,742	38.9
1946	2,057	1,726	1,592	1,039	5,715	12,130	47.1
1949	2,579	2,058	1,655	1,230	7,496	15,018	49.9
1952	3,303	2,316	1,910	1,316	9,928	18,771	52.9
1955	4,153	2,486	1,973	1,337	12,459	22,408	55.6
1957	4,858	2,824	2,266	1,430	14,781	26,159	56.5

Source: Compiled from data given in *Pulp and Paper* (Miller-Freeman Publications, Bristol, Conn.), Vol. 31, No. 8 (July 10, 1957), pp. 163–166. One objection which may be raised in regard to woodpulping capacity figures is that they are based upon the assumption of a 310-day year, which is appropriate for Northern mills but not for those located in the South, where mills operate on a round-the-clock, seven-days-a-week, 50-weeks-a-year, basis. Thus, the figures shown above probably underestimate the share of woodpulping capacity now located in the South.

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[7] *Ibid.*, Table 5, p. 25; trend computations are my own.

[8] Harry Brandt, *The Southern Pine Industry in the Sixth District* (Fed. Res. Bank of Atlanta: July 1956), Economic Study No. 5, p. 17. According to Brandt, the twelve Southern states furnished a market for 17 per cent of all rail shipments made by 108 Douglas-fir mills whose combined output accounted for nearly half the industry's total production.

[9] Yellow-pine flooring, for example, has sold at f.o.b. mill prices only 20 to 25 per cent higher than those quoted for Douglas-fir, a margin which has been relatively invariant. *Commodity Yearbook: 1958* (Commodity Research Bureau, Inc., New York: 1958), pp. 207-208. On other items, the spread has been even less.

Under these circumstances, prospects for a revival of the Southern lumber industry do not appear overly bright.

III

In direct contrast to the situation in lumber, Southern pulp and paper manufacturing has expanded prodigiously. Development of this forest-products sector did not begin on a large scale until the mid-1920's, when mills began to move into the region to take advantage of the forest remnants left by departing lumber interests. A second wave of expansion swept the South in the late 1930's, but this was cut off by World War II. Since the war, construction of 25 new mills and expansion of existing mills has nearly tripled plant capacity (see Table 2). With more than two-thirds of the nation's postwar additions to pulping capacity taking place in the South, by 1958 the region was able to boast of producing 60 per cent of the country's woodpulp and more than 40 per cent of its paper and paperboard.[10] Southern mills in 1956 were said to have a replacement value of 2.87 billions of dollars, and were spending in excess of a billion dollars annually for labor and raw materials.[11] By 1956, value-added by pulp and paper manufacturing was only slightly less than that of *all other* forest-products industries in the South.

The fabulous growth seems likely to continue. A growing population, mounting national per capita consumption of paper and paperboard,[12] and an expanding list of other uses for pulp[13] all point toward increased overall demand, with Southern mills especially likely to reap the benefits. This prediction is based not only upon the cost advantage held by South-

[10] *Pulp, Paper and Board: 1958* (U. S. Dept. of Commerce, Wash., D.C.: July 24, 1959) Facts for Industry Series M26A-08, pp. 5-6.

[11] *In the South . . . The Woods are Full of Prosperity* (Southern Pulpwood Conservation Assn., Atlanta: 1957) pp. 4, 19.

[12] In 1900, per capita consumption of paper and board amounted to only 60 pounds, requiring .04 cords of wood. Estimates for succeeding years place per capita consumption at 180 pounds in 1925, 300 pounds in 1939, 400 pounds in 1953, and 433 pounds in 1957, with the 1957 consumption requiring .28 cords of wood per person. By 1975, it is estimated, per capita use will rise to 533 pounds. See *Timber Resources . . . , op. cit.*, p. 14, and *In the South . . . , op. cit.*, p. 11.

[13] At the present time, about a million tons of woodpulp are used each year for other purposes, chiefly in the production of rayon and cellophane, with minor amounts going into the production of acetic acid, methyl alcohol, fertilizers, paint and varnish removers, smokeless powder, and other items. Recent developments in plasticizing and in the use of polymers have greatly increased the usefulness of paper for wrappings, tissue, toweling, packaging, and so on, thus permitting paper to be substituted for other materials in an ever-widening range of uses. Lignin, which comprises nearly half the weight of wood, is a complex substance for which very few uses have been found, and for which a bright future is predicted—so bright, indeed, that chemists have predicted that pulp someday may be a by-product of the "lignin mills" of the South!

ern mills,[14] but also upon the fact that the pulp itself is a technically superior product in many uses to which it is commonly put, such as in wrapping paper, bags, and paperboard.[15]

Pulpwood production, accordingly, has sky-rocketed. In 1925, Southern forests produced only about 600,000 cords of wood, or roughly 12 per cent of total domestic output. In 1958, Southern forests supplied more than 20 million cords of wood, or 61 per cent of the nation's domestic supply. And, while hardwood output increased ten-fold during this period, softwood output was 57 times larger in 1958 than it was in 1925.[16]

Conservative projections point to national consumption of 42 to 47.5 million cords of domestically produced wood by 1975, with the South's quota estimated at between 30 and 35 million cords.[17] Thus, within a short decade and a half, the Region's contribution is expected to grow to an amount approximately equal to current national output. If it is assumed that the present downward trend in lumber production levels out, the cubic-foot drain of softwood pulpwood—until recently less than for lumber—will amount to 62 per cent of the combined lumber-pulpwood drain.[18] If the postwar lumber decline continues until 1975, however, pulp

[14] The ability to produce pulp at a lower cost than elsewhere can be attributed to a number of factors, including a favorable climate which speeds the growth of trees and makes logging an all-year occupation, a high yield of pulp per cord of wood, cheap stumpage and other raw materials, low-cost labor, inexpensive materials assembly and finished-product transport, and nearness to markets.

[15] About 75 per cent of all Southern pulp is sulphate or "kraft" pulp (made with sodium sulphite), which is characterized by great length, and thus strength, of fiber. Kraft's advantage stems from the fact that it is lighter for any given strength, or stronger for any given weight, than any pulp produced elsewhere. In 1955, mills in the South produced about 82 per cent of the nation's supply of sulphate pulp. *Pulp and Paper* (Miller-Freeman Publications, New York), Vol. 30, No. 8 (July 1956), p. 153.

[16] Computed from data given in J. F. Christopher and Martha E. Nelson, *Southern Pulpwood Production, 1958* U. S. Forest Service, Southern and Southeastern Forest Experiment Stations: 1959), p. 9. In 1925, the South produced equal amounts of hardwoods and softwoods; in 1958, hardwoods accounted for only 3.1 million cords of the 20.2 million cords of pulpwood produced in the South.

[17] The assumption is implicit that no major recession occurs. The 42 million cord figure is a "lower-level" estimate by the Forest Service, and the 47.5 million figure is an estimate by the Stanford Research Institute. Both appear to be ultra-conservative, for actual consumption has run well ahead of projected totals (e.g., the 1955 consumption of 33 million cords equals the Stanford estimate for 1960). Planned mill expansion seems likely to push consumption to higher levels. A 1957 Dept. of Commerce study predicted a 14.1 per cent capacity increase during 1956-1965, which would place 1965 consumption at 35 million cords. If this pace were to continue, national consumption would reach 72 million cords by 1975, with the South contributing 43 million cords. *The Paper Industry* (Fritz Publications, Mendota, Ill.: Oct. 1956), Vol. 38, No. 7, p. 603; see also *Technical Guide to Pulp, Paper and Board Supply-Demand* (U. S. Dept. of Commerce, Wash. D.C.: June 1957), p. 3.

[18] Assuming 72 cubic feet of wood in a cord of pulpwood, and 167 cubic feet of wood in a thousand board feet of lumber, then a 1956 total drain of 17.4 million

and paper mills will account for 80 per cent of drain.[19] In this event, the pulp and paper industry will employ half the labor force and will create three-fourths of the dollar payrolls and nearly 85 per cent of the value-added of the two industries combined. Such an extreme is most unlikely, but the fact remains that Southern forestry's brightest prospects apparently lie in continued rapid expansion of the region's pulp and paper industry.

IV

Dramatic changes have occurred in the management of the South's timber resources, both reflecting and contributing to the changed economic environment faced by buyers and sellers of wood.

On the buying side of the market, the motivations of lumbermen must be contrasted with those of pulp and paper mill owners. The former moved into the South only after the forests of New England and the Lake States were virtually depleted and had proved uneconomical to log. As Eldredge has pointed out, it was unlikely that an industry long-accustomed to movement, and confronted with an unfavorable land-tax situation in the South, would take anything more than a short-sighted viewpoint toward forests and forestry, particularly when:

> . . . the young nation was growing mightily, and the spirit of the time was fired by one of the greatest markets for building materials . . . the world has ever seen . . . [and] . . . there was the comfortable if somewhat hazy belief that just over the horizon stretched an unlimited forest of fine old timber that the logger's axe could never deplete.[20]

Conditions which faced the pulp and paper interests were altogether different. Capital investment in buildings and heavy machines was much too great for millowners to "pull up stakes" and move. Thus, confronted with the necessity of remaining in the region and with a newly-awakened public apprehension that the remaining second-growth might also be lost, pulp and paper manufacturers found it necessary to reject the lumberman's practice of cutting timber without replacing it. Such attempts as were made by individual companies to purchase land generally met with

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cords of pulpwood and 8.2 billion board feet of lumber together amounted to 2.62 billion cubic feet, with pulpwood accounting for 47 per cent. This rose to 51 per cent in 1957, and remained at that level in 1958. For conversion factors, see *Timber Resources . . .*, *op. cit.*, p. 642.

[19] If the present pine-hardwood production ratio (5.67 to 1) were to remain constant, then 1975 pine pulpwood output would total 30 million cords. "Furniture and Fixtures" has been consuming a steadily-expanding volume of wood (chiefly hardwood varieties), partly counter-balanced by a decline in consumption of wood for fuel.

[20] I. F. Eldredge, *The 4 Forests and the Future of the South* (The Charles Lathrop Pack Forestry Foundation, Wash., D.C.: 1947), p. 6.

little success.[21] It soon became apparent that a high proportion (80-90 per cent) of the pulpwood supply would come from the many extremely small, poorly-managed woodlots of farmers and other private, non-industrial owners. To ensure the production of a continually expanding volume of wood, the industry joined with public agencies in a broad program designed to educate landowners in sound management practices,[22] and in 1939 formed the Southern Pulpwood Conservation Association. This agency immediately set forth the specific operational procedures and practices to be followed by members in seeking perpetual reforestation of the Southern region.[23]

Where sellers of wood were concerned, it seems quite certain that examples and preachment would not have been enough, by themselves. An economic motive had been added, however: the knowledge that there now existed an outlet for a product which could be sold in smaller quantities than previously had been needed to attract the attention of lumbermen, and which, therefore, nearly every landowner could grow and harvest. Behind pulpwood lay the rapidly-expanding market for finished products of pulp and paper, promising (unlike lumber) stability in demand and a reduction of the speculative element which had previously attended the planting and care of trees. Even more important, perhaps, was the realization that pulpwood, unlike sawtimber, could be grown and harvested several times on a given plot within one individual's adult life-span, so that planting and management of woodlots became an investment in a highly marketable and easily liquidated asset and not a long-term trust or legacy to be passed on to future generations.

Finally, brief mention must be made of the development by the pulp and paper industry of a mechanical loading machine, which led to the creation of permanently located "mechanized" woodyards or markets in

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[21] Some few mills were able to purchase large blocks of land from the departing timber interests, but the remaining lumber companies also soon began to recognize advantages in long-term planning and reforestation. By 1956, purchases of land totalled about 18.5 million acres (less than 10 per cent of available commercial forestlands), only 15 per cent of which was obtained in blocks of 500 acres or less, and only about 2.5 per cent of which involved croplands subsequently retired from crop cultivation. See: *In the South . . . , loc. cit.*

[22] Early public efforts were limited chiefly to expansion of forest fire protection (following enactment of the Clarke-McNary Act of 1924), although other measures were applied to the national forests, acquired for the most part in the 1930's. In recent years, government programs (education, fire and insect control, planting, etc.) have expanded rapidly, particularly at the state level.

[23] In 1956, the Southern pulp and paper industry provided services to 30,947 landowners (acreage totalling better than 8 million), made available to them a goodly share of the time of 1,025 foresters, and furnished them with 56 million seedlings. Game refuges, joint forestry research projects, college scholarships, youth forest camps, and school forest programs also were sponsored by the industry. *In the South . . . , op. cit.*, p. 19.

nearly every important wood-producing county in the South.[24] This innovation opened the pulpwood market to owners of small woodlots (chiefly farmers, many of whom previously had no outlet for their driblets of wood). Its significance can only be judged in the light of the information that in 1952, for example, forestland holdings of less than 100 acres numbered 1,476,000, or 80 per cent of the private, non-industrial, forest ownerships in the South.[25]

As a consequence of these developments, a revolution in forestry took place in the South. Growth ratios, which had been improving slowly but which were yet unfavorable prior to and during World War 11, by 1952 assumed proportions undreamed of less than a decade earlier. In 1944, for example, growth of softwood timber and growing stock amounted to only 91 and 94 per cent of "cuts" in these respective categories; by 1952, growth exceeded removal by 22 per cent for softwood timber and by 17 per cent for growing stock. The region was now able to boast that it led the nation in growth of both sawtimber and growing stock, with Southern pine accounting for more sawtimber growth than all other softwoods combined and for 30 per cent of the entire nationwide growth in both hardwoods and softwoods. Additions to Southern pine growing stock constituted nearly half of all softwood growth in this category and about a fourth of the combined increase in hardwood and softwood growing stock throughout the nation.[26]

What has happened in the period since 1952 will not be known until the next timber survey is made. Presumably, however, the situation has improved. For one thing, sharp reductions in the use of wood as fuel have occurred, particularly in very recent years. For another, use of wood residues for pulp has increased; whereas there was only one debarking and chipping installation in use in the South in 1952, by 1958 there were over 400, the combined output of which was estimated at the equivalent of 1.8 million cords per year.[27] Eventually, this may reach 2.5 million cords a year. In addition, losses from fire, though yet extensive, have been reduced appreciably in recent years. In 1938, fires in the South consumed an estimated 28 million acres of forestland. This dropped to about 13.5 million acres in 1949 and to about 7 million acres in 1954.[28] Tree planting,

[24] The mechanical loader was unknown in the South prior to 1950. By 1955, there were 400 in operation, and by 1956, an estimated 620. For a discussion of the impact on pulpwood markets and marketing practices, see: A. I. Jefford, Jr., "Trends in Pine Pulpwood Marketing in the South," *Journal of Forestry*, Vol. 54, No. 7, July 1956, pp. 464 ff.

[25] *People and Timber, A Survey of the Timber Resource Review* (U. S. Dept. of Agr., Wash., D.C.: June 1956), Misc. Pub. No. 721.

[26] *Timber Resources, op. cit.*, p. 46.

[27] *Southern Pulpwood Production, 1958, op. cit.*, p. 4.

[28] Derived from estimates presented in *The Conservation Yearbook: 1956* (Cornell, Inc., Wash., D.C.: 1956), 4th Ed., pp. 174-175.

which does not lead to an immediate increase in usable timber, but which serves, at least, as an index of the interest shown by landowners in forestry, has increased by leaps and bounds. Minor strides were made under Section 4 of the Clarke-McNary Act until after World War II; progress since that time, and especially since passage of the recent Soil Bank Act, has been remarkable. In all of the years preceding 1955, only 3.5 million acres of land were reforested in the South; in 1955 alone, seedlings reached nearly a half-million acres, while the 1957-1958 planting-season gains were estimated at a million and a quarter acres (thirteen times as much as in 1947-1948, only a decade earlier).[29] In 1958 a planting goal was set of complete reforestation of the South's remaining denuded lands within a period of ten years.[30] Various state "Keep Green" movements have expanded the scope of their activities, and a rapid multiplication has taken place in the number of, and acreage covered by, accredited "Tree Farms."[31] Much remains to be done, but progress has been rapid and shows no signs of slowing down.

Insofar as wood supplies are concerned, quantity does not appear likely to pose a problem for the pulp and paper industry. Some difficulties, it is true, may be encountered in regard to quality, size, and species composition, and low productivity on many of the smaller landholdings indicates that the process of education has by no means been completed.[32] Even here, however, there have been encouraging signs: a 1945 survey, for example, showed that only two per cent of the small-woodlands owners were cutting in a "highly productive" manner, whereas the figure had increased to 40 per cent by 1956 and was steadily improving.[33] Finally, it is only reasonable to expect that particular firms, because of their location, may not find the situation as favorable as that which is pictured here.

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[29] In 1958, a total of 62 forest-tree nurseries (33 state, 24 forest industry, four federal, and one private) expected to produce 1.25 billion seedlings, enough to plant 1.8 million acres of land in that year (assuming 700 trees per acre). D. A. Craig, "We Can Do a Better Tree Planting Job," *The Unit* (Southern Pulpwood Conservation Assn., Atlanta: Feb. 1958), p. 9.

[30] It was estimated that 25 million acres needed reforestation, including 17.5 million which remained of the 20 million reported by the *Timber Resource Review* in 1953, another 2.5 million acres of "old fields," 4 million acres of Soil Bank land, and 1 million acres of land expected to be clear-cut during 1958-1968. *Ibid.*

[31] The Tree Farm movement did not begin in the South until 1943. By 1956, there were 4,017 tree farms in eleven Southern states (only Oklahoma had none), covering about 24 million acres of land. In 1956 alone, 1,096 tree farms were added, and coverage was extended to another 2.5 million acres. By 1956, the South contained 64.1 per cent of all U.S. timberlands encompassed by the program. See *The Conservation Yearbook, op. cit.*, p. 145.

[32] Southern landholdings average about .4 cords per acre in annual growth, which compares very unfavorably with the 2 cords per acre achieved on many company plantations.

[33] *In the South . . . , op. cit.*, p. 11.

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If wood supplies are not likely to deter growth of the South's pulp and paper industry, what (if anything) will block expansion? Water, chemicals, and electricity, all of which are used in great amounts, are available in quantities sufficient to meet foreseeable needs. These may have an effect upon the size and location of individual mills, but are unlikely to place limits on the size of the industry as a whole.[34]

Within the past several years, most of the concern has focused on two main issues: (1) whether labor shortages may develop in the woods because of the large rural-farm outmigration, thus indirectly limiting wood supplies; and (2) whether public controls will be placed into effect limiting timberland acquisition by mills and providing for supervision of cutting practices on all lands, perhaps stifling further investment and killing the economic incentives responsible for the remarkable changes which have taken place in Southern forest management.

The labor-shortage hypothesis first came to light in 1955, when mills throughout the South found inventories dwindling to precarious levels. A declining rural-farm population cannot be said to have caused this, however, principally because most of the wood is produced by rural non-farm inhabitants, who have increased in numbers in recent years.[35] Rapid additions to capacity during 1954-1955 and an apparent unwillingness to increase the price of wood offer a better explanation of the phenomenon.[36] In some few areas of the South, particularly where negro labor is used extensively in pulpwood production, some adverse effects may stem from

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[34] Future industry growth will be more "internal" than in the past, chiefly because existing mills occupy the prime mill-sites, where large quantities of effluent can be disposed of handily. Much growth can be expected on the Piedmont "fall-line" because of proximity to relatively unexploited timber areas; here mills are apt to be small and medium-sized, however, for rivers are not large.

[35] A 1950 study placed contributions to total supply by "farmers and others" at less than three per cent of the wood supply in the South. *Equipment, Supplies, and Manpower Used by Primary Forest Products Industries, 1950* (U.S. Forest Service and National Production Authority, Wash., D.C.: Dec., 1951), p. 27. My own investigations in 1956-1957 indicate that farmers may supply as much as 15-20 per cent in recently-tapped market areas and during the "off-cropping" season. See: *Economic Problems of Pine Pulpwood Production in the South and in the Hiwassee Region,* Ph.D. Diss., Vanderbilt University (University Microfilms, Ann Arbor: 1959), pp. 233-235. Finally, in regard to population, we may note that although the rural farm population declined by 24.1 per cent in the Southeast during 1940-1950, the rural and rural non-farm populations increased, respectively, by 4.3 and 55.5 per cent. *U.S. Census of Population* (Dept. of Commerce, Wash., D.C.: 1940 and 1950), Vol. II, Part 1.

[36] During 1954, capacity increased by about ten per cent through addition of six new mills; to this must be added expansion of existing mills, which by the end of 1955 were consuming wood in their new facilities at a rate equal to about 11.6 per cent of the total 1954 output. Cf. *Pulpwood Production in the South* (since 1958 titled *Southern Pulpwood Production*), *op. cit.*: 1954, p. 13; 1955, pp. 27-29.

emigration; the general outlook, however, is for off-farm migration to add to the already large pool of rural non-farm labor from which the bulk of the labor force is drawn, thus obviating the possibility that shortages of wood may result from labor non-availability.

A shortage of "producers," or small-scale entrepreneurs who organize and direct pulpwood businesses, should not be lightly discounted, however. These individuals are less immobile, better educated, and financially somewhat better off than their workers, possessing greater "outside" opportunities. Moreover, there is always the imminent possibility that the current 12-employee exemption from the Fair Labor Standards Act, presently applicable to the vast majority of operating units in the industry, may be withdrawn. Should this occur, producers may be forced from the industry for one or both of two reasons: (1) it is almost impossible to maintain records for scattered workers who receive little supervision in the woods and who are normally paid on an incentive (per-cord) basis, especially if one is illiterate or semiliterate (as many producers are), and (2) a large proportion of all units are currently operating at the margin, and a forced wage increase would deliver the *coup de grace*. Purchases of labor would be reduced, and/or increases would be sought in the price of wood. Since organizational and production changes (especially where mechanization is concerned) could not be undertaken because of the small size of timber stands and their scattered locations, price increases would be passed along to mills, reducing their competitive advantage and thus tending to discourage expansion.

The second issue, which involves political controls sought in the name of "conservation," is a serious one. Within recent years, bills to limit industrial ownership of forestlands (to 10,000-15,000 acres) were narrowly defeated in the Alabama and Mississippi legislatures, proponents of the measures heatedly arguing that "paper companies are gobbling up the land," and that "farmers are being run off their tillable acres." As noted above, company land purchases have not been extensive, and only a small percentage involved lands retired from cultivation. Crop surpluses and tired soils, and not pressure from prospective buyers, have dictated the mass exodus from agriculture. It can be argued, indeed, that mills have kept farmers on the land by providing them with supplementary income from woodcutting, often to the detriment of agriculture's best long-run interests. Such adverse effects, however, have been more than offset by the many jobs, high wages, and large payrolls which mills have brought to rural areas, and by taxes paid on lands quite often abandoned as useless and, more often than not, tax-delinquent.

The attempt to establish control over cutting practices—which thus far has taken the form of prescribing the minimum size at which timber may

be cut and the minimum number of seed-trees which must be left on each acre of land to aid in the process of reforestation—apparently stems from a popular misconception as to what is meant by the term "conservation." Many state legislators, as well as much of the general public, seem to view conservation as preservation of the *status quo*. The implication is that controls must be instituted because of too rapid rates of resource use, which result from a discrepancy between social and private costs, from the admittedly limited time-perceptiveness of the individual and firm, and from the short-run profit calculus. If conservation is properly thought of, however, as the attempt to redistribute rates of use over time "in the direction of the future," and if one perceives that growth-cut ratios in the South have been improving, rather than deteriorating, it follows that such controls are not needed.[37] Should growth-cut ratios become unfavorable in the future, steps might then be taken to correct the situation.

In this connection, also, brief mention must be made of two related ideas which have gained widespread acceptance from those who have favored control: these are the "sustained yield" and "diversified products" concepts. The former envisions continuous output of forest products from trees of all sizes on a given timber stand, while the latter stresses the desirability of a flow of varied products (e.g., lumber, poles, pulpwood, etc.) from any given stand. In these limited but common meanings, neither idea suggests that it may be possible to obtain balance in production from an inter-stand, as well as an intra-stand, basis, and both ideas ignore the benefits which accrue from specialization. On plantations, there is a distinct (though not as yet clearly established) possibility that a 30-year rotation, with "clear-cutting," will yield a greater volume of wood than can be obtained by practicing "European-style" forestry.[38] On the many small ownerships, problems of indivisibility arise, raising serious question whether the sustained-yield and diversified-products concepts are applicable in the South. It is difficult, moreover, to sell these ideas to individuals perenially confronted with financial crises. The practice of cutting and not replacing timber will become less serious as farms grow in size and as access to financial resources improves; for this reason, the solution may be to promote farm consolidation and to improve capital

[37] Probably no word is so "loaded" with value preconceptions as "conservation," nor has any word more disparate meanings in economic and general usage. Ciriacy-Wantrup has pointed out that use of the term to mean preservation of the *status quo* is inaccurate where "stock" resources are concerned, and is downright misleading where "flow" resources are involved. Conservation is a dynamic process, so that directions of change are important, and not existing rates of use. S. V. Ciriacy-Wantrup, *Resource Conservation* (U. of Calif. Press, Berkeley: 1952), Ch. IV.

[38] Some indication that this may be true is to be found in the fact that several companies have adopted the 30-year rotation on a large scale. See: "St. Regis Goes Around in Circles," *Pulp and Paper, op. cit.*, Vol. 31, No. 6 (June, 1957), pp. 134-135.

markets, if indeed any solution is required. The real danger, it is clear, is not that a given individual may strip his woodlot, but instead is the possibility that overall planting and natural regeneration may not equal the drain from all tracts. As we have seen, growth ratios have become favorable in the South because of a response to the free play of economic incentives, operating in an atmosphere relatively unfettered by restrictions. In Southern forestry, as in many other areas of the economy, it may make sense to leave the supply-demand balancing processes chiefly to the market.

ESTIMATES OF THE AGGREGATE U.S. FARM SUPPLY FUNCTION

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1. *Introduction*[1]

EVEN though most of the recent farm policy debate has been really a debate about the responsiveness of farm output to price changes, no direct empirical estimates of the aggregate farm supply elasticity are available. There is a whole literature on why the elasticity is low[2] and some statements (mainly by politicians) implying that it may be negative, but no direct econometric numerical estimates of it.[3] There is a growing body of supply elasticity estimates for individual farm commodities,[4] but these, while very informative, do not really meet the bill. The fact that individual commodity elasticities may be positive and relatively high does not preclude the aggregate supply elasticity from being zero or negative.

It is easy to understand why we have had so few supply elasticity estimates. Annual fluctuations in farm output are heavily dominated by random fluctuations in "weather." This has led some investigators to use acres rather than output in their supply studies of individual farm commodities. For similar reasons, I attempted, in a previous paper, to infer the aggregate supply elasticity from estimates of the demand elasticities for agricultural inputs.[5] The pioneering work of Stallings, however, has provided us with a tool that may enable some estimates of the aggregate supply elasticity after all. Stallings has developed a measure of the impact of fluctuations in "weather" on aggregate farm output based on experimental ("check-plot") yield data.[6] This measure may allow us to "take out" the random effects of weather and investigate the responsiveness of the remainder to the more interesting economic forces.

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[1] This paper is an outgrowth of a larger study of technical change in agriculture supported by a generous grant from the National Science Foundation. It was completed during my tenure as Research Associate at the National Bureau of Economic Research, but it is not a National Bureau report.

[2] I shall list only a few of the most important papers in that area: Cochrane (2), Heady (9), and Johnson (10). (The numbers in the parentheses refer to the list of references at the end of this paper.)

[3] Cochrane in (1) and (3) does present a scatter of output and prices but does not subject it to detailed analysis.

[4] For some of these studies and further references see Nerlove (4) and the November 1958 issue of *J. Farm Econ.*

[5] See Griliches (7).

[6] See Stallings (16).

No good remedy has been found, however, for the problem of changing technology besetting the supply analyst. It may not violate reality too badly to assume that the demand functions for agricultural products have remained relatively stable with the passage of time, but no such assumption is possible for supply. The underlying technological conditions have changed too much. I shall try to circumvent this problem by assuming that technological changes have shifted the supply function gradually and more or less at a constant rate throughout the whole period (or sub-periods) under analysis. This seems the best that can be done at the moment, barring independent estimates of the impact of technological change.[7]

The purpose of this paper is then to present some estimates of the aggregate U.S. farm supply elasticity, using a relatively simple econometric model. In a sense, it is a preliminary report. It is not based on a very extensive research project. Rather, I wanted to see whether with the help of Stallings' weather index and a simple distributed lag model one could get any results at all. It seems that we can.

In the next section I shall outline briefly the model used and present the main results for aggregate U.S. farm output and two sub-aggregates: "all crops" and "livestock and livestock products." The subsequent and last section will summarize the results and discuss them in the light of previous work in this area.

2. *Empirical Results*

Briefly speaking, the supply of farm products is a function of relative prices, weather, the state of technology, and other variables.[8] The major price response is assumed to be to the "real" price of farm products—the index of prices received relative to the index of prices paid for production items, wages, taxes, and interest. (The resulting series differs from the official "parity" index by excluding the "prices paid for items used in living" from the deflator.) Since farmers may respond only slowly to changes in relative prices and other variables, I shall use a distributed lag model which leads to the introduction of lagged farm output as an addi-

[7] There is no point in using one of the estimated output-over-input indexes of technological change, e.g. from (17), for these purposes, since it would effectively bring us back to the approach used in (7). Using an output-over-input index as an independent variable in a logarithmic regression explaining output, we hold constant those changes in output that are not associated with changes in the input index. This is equivalent to substituting the input index for the output index as the thing to be explained by the other variables. But that is essentially what was done in (7).

[8] Note that throughout this paper I am explaining *output* not *sales*. In the long run, the two move closely together, but for short periods they may move in opposite directions. The concentration on output relieves us from considering a whole host of speculative and inventory investment factors that may affect the timing and hence also the volume of sales.

tional independent variable.[9] Output is measured by the ARS Index of Farm Output, prices by the USDA price indexes as of March 15 of the *same year*,[10] the impact of weather by Stallings' weather index, and the impact of technological change by a trend variable. All variables are expressed as logarithms of the original values except for trend, which enters linearly.[11] The use of a linear trend in a logarithmic equation assumes that the supply function has been shifting to the right at a constant (compound) percentage rate.

The analyses for the "all crops" and "livestock and livestock products" sub-aggregates of the output index differ from the aggregate analysis only in a few minor aspects. The analysis of the sub-aggregates covers a longer period, 1911-58, whereas the aggregate analysis is restricted to the 1920-57 period. For "all crops" the prices received index is the "all crops" sub-index of the USDA prices received index, and the "weather" index is the particular Stallings' index that is appropriate to the "all crops" category. In the analysis of the output of "livestock and livestock products" a weather variable is not included and the price of feed is treated separately. Estimates were made including both livestock prices and feed prices separately (each deflated by the total index of prices paid for production items, wages, taxes, and interest) and using a ratio of livestock to feed prices. The price of livestock and livestock products is the relevant sub-index of the prices received index, and the price of feed is the sub-index of the prices paid index. All prices in the livestock analysis are averages for the *previous* calendar year.[12]

Table 1 presents the results of supply analyses of aggregate farm output for the periods 1921-57, 1920-57, 1920-36, and 1937-57. Tables 2 and 3

[9] The distributed lag model assumes that desired output S_t^* is a function of a set of variables P_t, $S_t^* = F(P_t)$, but that actual output will change only by some fraction of the difference between the desired and the previously achieved output: $S_t - S_{t-1} = b(S_t^* - S_{t-1})$. Taking the two equations together and solving for actual output, leads to the estimating equation $S_t = b\ F(P_t) + (1\text{-}b)\ S_{t-1}$. The same model can be interpreted as an expectation model in P, where output depends on expected P, and expected P is adjusted by some fraction of the discrepancy between the previously expected P and the actually realized one. For a more detailed description of such models see Griliches (5) and Nerlove (14). Due to the importance of random "weather" effects we should, strictly speaking, distinguish also between planned and actually realized output, not only between desired and actual. Alternatively, one should include the weather variable in the adjustment equation rather than in P. Both of these elaborations would lead to the introduction of lagged "weather" into the estimating equation. However, when tried, the coefficient of lagged weather, while having the "right" (negative) sign, was not statistically significant from zero in the various regressions, and hence this distinction will not be pursued further here.

[10] Several experiments with alternative lags indicated that this was the best choice.

[11] A logarithmic supply function is equivalent to the assumption of a Cobb-Douglas type aggregate farm production function.

[12] Several experiments with alternative lags indicated that this was the best choice.

TABLE 1. ESTIMATES OF THE AGGREGATE U.S. FARM SUPPLY FUNCTION

Equation No.	Period	Coefficients of— "Real" Price	Weather	Trend	Lagged Output	R	d
1.1	1921–57	.131 (.068) [.318]	.283 (.095) [.461]		.880 (.058) [.935]	.951	2.27
1.4	1921–57	.094 (.051) [.308]	.434 (.070) [.731]	.0068 (.0003) [.964]		.973	1.23*
1.5	1921–57	.095 (.045) [.319]	.383 (.065) [.723]	.0047 (.0007) [.758]	.298 (.096) [.481]	.979	2.06
1.6	1920–57	.101 (.043) [.377]	.385 (.064) [.725]	.0046 (.0007) [.761]	.303 (.095) [.486]	.980	2.22
1.6 A	1920–36	.047 (.092) [.145]	.480 (.112) [.777]	.0043 (.0015) [.636]	.327 (.215) [.402]	.798	1.88*
1.6 B	1937–57	.168 (.045) [.686]	.160 (.071) [.491]	.0076 (.0010) [.876]	.006 (.108) [.014]	.981	2.27

Notes: All variables are expressed as logarithms of the original values except for "trend," which is entered linearly. Hence all the coefficients (except trend) are also elasticities.

The numbers in the parentheses are the calculated standard errors. The numbers in the square brackets are the respective partial correlation coefficients. R is the multiple correlation coefficient and d is the Durbin-Watson test statistic for serial correlation in the residuals. Loosely speaking, values of d around 2 indicate no (first order) serial correlation in the residuals, values of d around and below 1 indicate the presence of statistically significant positive serial correlation in the residuals. The test is often inconclusive for d-values between 1 and 2. In the table, unstarred values of d indicate the rejection of the hypothesis of positive serial correlation at the 5 per cent significance level; one star denotes that the test is inconclusive, and two stars imply the acceptance of the hypothesis of significant positive serial correlation in the residuals of the particular regression.

The Variables:

Output—The dependent variable is the Index of Farm Output from USDA, ARS, *Changes in Farm Production and Efficiency.*

Weather—Stallings' index of weather (farm output) (16).

Trend—"Time" ($t=0, 1, 2, \cdots, 37$). The use of a linear time trend in a logarithmic equation implies a compound interest rate of growth over time. A coefficient of 0.005 implies a rate of growth of output of 1.2 per cent per year. A coefficient of 0.007 implies a 1.6 per cent rate of growth.

"Real" Price—Index of Prices Received for all Farm Products divided by the Index of Prices Paid for items used in production, wages, taxes, and interest. Both indexes are as of March 15 of the *same* year as the output index. Source: USDA, *Agricultural Prices.*

Lagged Output—Output in the previous year.

present similar results for the "all crops" and "livestock and livestock products" sub-aggregates respectively covering the periods 1911-58, 1911-34, and 1935-58. Throughout all these Tables the price coefficients have always the expected sign and are significantly different from zero at the

TABLE 2. ESTIMATES OF THE U.S. AGGREGATE FARM SUPPLY FUNCTION OF "ALL CROPS"

Equation No. and Period	Coefficients of—				R	d
	"Real" Price	Weather	Trend	Lagged Output		
1911–1958						
1.1	.164	.392	.0028	.299	.939	2.09
	(.042)	(.064)	(.0004)	(.095)		
	[.505]	[.683]	[.688]	[.420]		
1.2	.172	.417	.0039		.926	1.27*
	(.047)	(.069)	(.0003)			
	[.487]	[.672]	[.898]			
1911–1934						
1.1 A	.076	.351	.0009	.248	.745	1.74*
	(.072)	(.083)	(.0010)	(.255)		
	[.237]	[.694]	[.190]	[.217]		
1.2 A	.061	.370	.0013		.730	1.09*
	(.070)	(.081)	(.0010)			
	[.190]	[.716]	[.281]			
1935–1958						
1.1 B	.159	.430	.0058	.042	.952	2.24
	(.061)	(.092)	(.0011)	(.110)		
	[.500]	[.733]	[.779]	[.088]		
1.2 B	.152	.428	.0062		.952	2.09
	(.059)	(.089)	(.0006)			
	[.498]	[.731]	[.922]			

Notes: Same as to Table 1 except that here the dependent variable is the Index of the Output of All Crops, and the Index of Prices Received is the Sub-Index of Prices Received for all crops (as of March 15 of the same year).

conventional significance levels in all cases except in the 1920-36 sub-period for aggregate output and in the 1911-34 sub-period for the all crops sub-aggregate. Also, all the other coefficients have the expected signs and are almost always statistically "significant" except for the coefficients of the lagged dependent variable, which will be discussed separately.

Our results seem to indicate a short run supply elasticity of aggregate farm output of about 0.1 for the whole period, about 0.17 for the more recent years, and—if one accepts the distributed lag model—a long run aggregate supply elasticity of about 0.15 for the whole period.[13] The last figure probably underestimates severely the "true" long run supply elas-

[13] The "long run" elasticities are computed by dividing the estimated coefficients by one minus the coefficient of lagged output. This provides estimates of the coefficient in the "desired output" equation, indicating by how much output would change eventually if the price change persisted indefinitely. One minus the coefficient of lagged output gives us an estimate of the "adjustment coefficient"—the fraction of the disequilibrium (the difference between desired and actual) that is eliminated within one period.

TABLE 3. ESTIMATES OF THE U.S. AGGREGATE FARM SUPPLY FUNCTION OF "LIVESTOCK AND LIVESTOCK PRODUCTS"

Equation No. and Period	Coefficients of— Price of Livestock	Price of Feed	Ratio of Livestock to Feed Prices	Trend	Lagged Output	*R*	*d*
1911–1958							
2.1	.194	−.191		.0014	.727	.990	1.63
	(.050)	(.057)		(.0006)	(.082)		
	[.507]	[−.458]		[.371]	[.804]		
2.2	.303	−.257		.0060		.973	0.48**
	(.081)	(.093)		(.0003)			
	[.492]	[−.385]		[.946]			
4.0			.193	.0014	.727	.990	1.63
			(.049)	(.0005)	(.080)		
			[.511]	[.378]	[.807]		
4.1			.295	.0059		.973	0.48**
			(.080)	(.0003)			
			[.483]	[.948]			
1911–1934							
2.1 A	.196	−.232		.0021	.414	.971	1.91
	(.064)	(.062)		(.0012)	(.205)		
	[.572]	[−.649]		[.363]	[.421]		
2.2 A	.185	−.234		.0044		.965	1.49*
	(.069)	(.067)		(.0006)			
	[.515]	[−.614]		[.873]			
4.0 A			.216	.0023	.431	.970	1.86
			(.058)	(.0012)	(.201)		
			[.641]	[.394]	[.431]		
4.1 A			.211	.0048		.964	1.44*
			(.062)	(.0004)			
			[.595]	[.945]			
1935–1958							
2.1 B	.190	−.346		.0015	.723	.981	0.90*
	(.071)	(.114)		(.0013)	(.126)		
	[.526]	[−.569]		[.257]	[.797]		
2.2 B	.309	−.362		.0082		.948	0.59**
	(.109)	(.185)		(.0008)			
	[.535]	[−.401]		[.907]			
4.0 B			.185	.0023	.676	.978	1.56*
			(.074)	(.0013)	(.130)		
			[.485]	[.373]	[.759]		
4.1 B			.305	.0083		.945	0.56**
			(.106)	(.0008)			
			[.531]	[.921]			

Notes: Same as to Table 1 except that here the dependent variable is the Index of Output of Livestock and Livestock Products; the Price of Livestock is the Index of Prices Received for Livestock and Livestock Products deflated by the Index of Prices Paid by Farmers for items used in production, wages, taxes, and interest; the Price of Feed is the Index of Prices Paid by Farmers for all Feed deflated by the above-mentioned Index of Prices Paid for all production items, etc.; Ratio of Livestock to Feed Prices is the ratio of the Index of Prices Received for all Livestock and Livestock Products to the Index of Prices Paid for All Feed. All the prices are averages for the *previous* year.

ticity, since much of what is here attributed to trend and technological change is actually due to changes in relative prices that are not caught by the conventional price indexes.[14] For "all crops" there is no significant price response during the 1911-34 sub-period. For the more recent years and for the period as a whole, the short run supply elasticity of "all crops" seems to be around 0.16, and the long run elasticity is about 0.23. The estimates for "livestock and livestock products" are surprisingly stable; indicating short run supply elasticities between 0.2 and 0.3 and long-run elasticities of about 0.4 for the first sub-period and about 0.7 for the whole period and the more recent sub-period. There is also very little difference between treating the price of feed separately or using the livestock-feed price ratio. The coefficient of feed prices has the opposite sign but is approximately equal to the coefficient of livestock prices in absolute value, and hence the use of the ratio of the two prices leads to practically identical results.

The weather index proves to be a very useful tool of analysis, accounting for a substantial fraction of the explained variance.[15] It is always significant and surprisingly stable. In the aggregate analysis the weather coefficient appears to be lower in the second sub-period. This, however, is due more to the inclusion of both extreme drought years (1934 and 1936) in the first sub-period and to the growing importance of livestock in the aggregate in the second period, than to any "real" causes. There is no such difference for the "all crops" sub-aggregate where the break between the sub-periods occurs in 1934, giving one bad drought year to each sub-period. On the whole, the results seem to indicate that a ten per cent change in the Stallings' weather indexes implies a change of about 4 per cent in both the total farm output and the all crops output indexes.

Our results indicate a substantial substitutability between "trend" and the lagged output variables. The coefficients of each of these variables are very much affected by the presence or absence of the other variable in the same regression. A measure of this substitutability is provided by the estimated correlation between the two coefficients. Table 4 presents the estimated "correlation coefficients" between the trend and the lagged output coefficients for selected regressions, and shows that they are negative and quite high.[16] This means that one can increase one of the coeffi-

[14] For an example of what I have in mind here see Griliches (5).

[15] The relative importance of the various independent variables can be gauged approximately, and only approximately, by comparing their partial correlation coefficients.

[16] These coefficients are computed by dividing the estimated covariance of the coefficients by the product of their respective standard deviations. For a more detailed discussion of such measures see Griliches (6), p. 97.

TABLE 4. ESTIMATED CORRELATION COEFFICIENTS BETWEEN THE COEFFICIENTS OF "TREND" AND LAGGED OUTPUT

Function and Equation No.		$\rho_{b_t b_{y_{t-1}}}$
Aggregate Supply		
	1.6	−.922
	1.6 A	−.012
	1.6 B	−.930
Crops		
	1.1	−.910
	1.1 A	−.377
	1.1 B	−.837
Livestock		
	4.0	−.942
	4.0 A	−.960
	4.0 B	−.913

Note: This correlation coefficient is computed by dividing the estimated covariance of the two coefficients by the product of their estimated standard deviations.

cients while reducing the other coefficient optimally (and vice versa) without increasing the residual variance much (or reducing the fit of the equation).

Even though the trend coefficients may appear to fluctuate a lot, once we adjust for the presence of lagged output there is very little difference between the estimated trend coefficients. Since in the versions that include the lagged dependent variable trend influences output also through its influence on lagged output, to get the full measure of the impact of trend we have to divide its coefficient by one minus the coefficient of lagged output. Once this is done, there is practically no difference between the trend estimates in the different equations. For the aggregate these estimates imply a shift of about 1.5 per cent per annum during the period as a whole and about 1.7 per cent per annum in the more recent (1937-57) sub-period. For "all crops" there is no significant trend in the first sub-period but a 1.4 per cent trend in the second (1935-1958) sub-period, averaging out to about 1 per cent per annum for the whole period. For livestock there is very little difference between these sub-periods: about 0.9 for the first, 1.4 for the second; averaging about 1.3 per cent per annum for the whole period. Only for livestock in the second sub-period do we get a higher trend coefficient if we exclude lagged output, indicating a shift of about 2.0 per cent per annum in the livestock supply function in recent years.

The coefficients of lagged output are reasonable for the whole period and perform particularly well for the livestock sub-aggregate,[17] but they do not stand up well either under a subdivision of the time period or under the addition or subtraction of other variables. If we accept the dis-

[17] This is in conflict with Dean and Heady (4), who found no evidence for the distributed lag model in their study of hog supply.

tributed lag model, the results indicate an adjustment coefficient of about 0.7 for the aggregate and the "all crops" sub-aggregate, and about 0.3 for livestock. The coefficient of lagged output is not significant in the second sub-period for the "all crops" sub-aggregate and this leads to similar results for the aggregate as a whole. The collapse of the distributed lag model in the more recent sub-period may be due either to the very high multicolinearity with trend in this period (see Table 4) or to "real" causes. One possible "real" explanation would be that the distributed lag model is really an expectational model, a way of projecting past price experience into the future. But since 1934 we have had price supports for crops (but *not* for livestock) with the support prices announced a fairly long time in advance of the harvest. This may then eliminate the rationale behind the consideration of past prices as being relevant for current decision making and would explain why in recent years the distributed lag model still works for livestock but not for crops.

Even though we may have some doubts about the role and appropriateness of lagged output in our equations, it does lead, however, to a substantial reduction in the serial correlation of the residuals from these regressions. All the regressions containing the lagged dependent variable have Durbin-Watson statistics around 2, implying either no or not conclusive evidence of serial correlation. On the other hand, if we exclude lagged output, the Durbin-Watson statistics fall to around 1, indicating either significant or non-conclusive evidence of the *presence* of serial correlation in the residuals. To the extent that serial correlation is an undesirable property of the residuals and to the extent that we believe that most of the serial correlation is due to not taking into account distributed lag effects, the Durbin-Watson statistics imply that we get "better" estimates when we include lagged output in the regressions and support the distributed lag model.[18]

Several attempts were made to improve these results without notable success. The following were tried: using prices as of the previous year, as of the current year (for the aggregate and all crops), and as of March 15 of the current year (for livestock); a different price deflator was tried, excluding wages, taxes and interest and using somewhat different weights than the USDA index; also I tried including farm wages, farm income, non-farm income, unemployment in the non-farm economy, land prices, and lagged weather as additional variables. All these, however, did not lead to any appreciable improvements over the above reported results.

3. *Discussion and Summary*

The estimates presented in the previous section obviously do not represent the last word on supply analysis. They represent rather, an explora-

[18] For further discussion of the role of serial correlation in distributed lag models see Griliches (6) and (8).

tion of the relevant orders of magnitude, using a very simple approach and model. More elaborate models will be needed to do full justice to the problem. In particular, the livestock supply function presents an over-simplified version of a very complex industry. Nevertheless, one must start somewhere, and I hope that these estimates will stimulate discussion and lead to further and better investigation in that most important area of agricultural econometrics.

One of the puzzles that emerges from this study is the relative instability of the distributed lag model. Even though it seems to perform well in studies of individual commodities, in studies of the demand for agricultural inputs, and in the study of aggregate livestock supply, it does not do nearly as well in the analysis of crop supply nor in that of aggregate farm output. While it does produce reasonable coefficients, it does not survive the division into two sub-periods (nor a first difference transformation). This may be due to several causes (besides the inappropriateness of the basic model): (a) the very high multicolinearity with trend; (b) the existence of price supports for crops after 1934, making the expected price equal to the support price or higher, and (c) the fact that measured output is not necessarily equal to planned output, due to "weather" and other random effects. This last factor would lead to a downward bias in the estimate of the coefficient of lagged output since the adjustment assumed by the model proceeds from the previously "planned" output, of which actual output is not an error-free measure. The presence of random measurement errors in an "independent" variable usually leads to a downward bias in its estimated coefficients. While the distributed lag model still seems to be a very useful tool of analysis, it may not be as much of a panacea as it appeared to some of us some time ago.

Our findings indicate small but definitely positive supply elasticities: About 0.1 to 0.2 for the aggregate and all crops, and 0.2 to 0.3 for livestock and livestock products. They also bring out the interesting fact that the supply function of all crops and the supply of aggregate farm output seem to have become more elastic in recent years. For crops this is consistent with Geoffrey Moore's findings in his study of Harvest Cycles that conformity of harvest cycles to business cycles has increased over time.[19] For the aggregate, the increased elasticity is due both to the increase in the crop elasticity and the increased importance of livestock (with a higher elasticity) in the total. No direct comparisons with other studies are possible, since the other published studies deal only with individual commodities and then mostly only with acreage response. These studies usually report somewhat higher elasticities, in the order of 0.5, but one would expect higher elasticities for narrower defined commodities.

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[19] See NBER (13), p. 35.

The only previously published attempt at a numerical estimate of the aggregate farm supply elasticity is derived from estimates of demand elasticities for agricultural inputs. In a previous paper I estimated that the short-run aggregate farm supply elasticity is about 0.3 and the long-run elasticity is about 1.0.[20] The present study does not provide reliable estimates of the long-run elasticity, but its short-run estimates are around 0.1 to 0.2, which is somewhat lower than the previously estimated 0.3. The input demand studies, however, were based mostly on models not including "trend." I attempted there to take account of the impact of technological change by measuring the relative prices more carefully and incorporating into the price measures some of the improvements in the "quality" of the inputs. Hence, much of the role of "trend" is taken over in the input studies by the price variables, leading to higher elasticity estimates. On the aggregate level, the conventional price indexes take no account of the improvement in the quality of many agricultural inputs, which is really technological change outside rather than within the agricultural industry, and attribute to "trend" what is essentially a response to changing relative prices. Hence the somewhat higher price elasticities found in the demand studies for various agricultural inputs are due mostly to a somewhat different concept of "price." Thus a large part of what appears as "trend" in this study, I believe, is really a response to a change in relative prices, a response to the fall in the price of a "constant quality unit" of purchased agricultural inputs—fertilizer, farm machinery, insecticides, and others.

The estimated trend coefficients are consistent with other estimates of technological change in agriculture based on output-over-input indexes. Our estimates indicate that the short run aggregate farm output supply function is shifting to the right at rate of about 1.5 to 1.7 per cent per annum, with the shift accelerating somewhat in the more recent period (this is seen most clearly in the trend coefficients for the sub-aggregates). Recent estimates by Ruttan and Stout imply a rate of technological advance in agriculture of about 1.5 to 1.6 per cent per annum, which is extremely close to our own estimates.[21] In a similar study, Kendrick finds that "total factor productivity" in agriculture grew during the 1919-29, 1929-37, 1937-48 and 1948-57 periods at 1.2, 0.8, 2.7, and 3.7 per cent per year respectively.[22] Hence our estimates of the rate of supply shift in agriculture seem to be quite close to estimates derived by a very different procedure.

All the above indicates, I think, that we have still a long way to go

[20] See Griliches (7).

[21] See Stout and Ruttan (17).

[22] The last figure is probably an overestimate due to a change in midstream in the labor series used by Kendrick. See Kendrick (11) and (12).

before we shall have precise and reliable estimates of supply elasticities. One thing is clear, however, the aggregate supply elasticity of agriculture is not negative or zero. Whatever evidence we have, points unequivocally to a small but definitely positive elasticity. This elasticity also appears to be getting higher with the passage of time. Moreover, I believe that if we were to measure our prices better, we would find that there is much more of a price response in agriculture than is commonly assumed.

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LAND SUBSTITUTES AND CHANGES IN CORN YIELDS

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I. *Introduction*

AN APPARENTLY widely held belief is that average fertilizer use has been substantially less than optimum for certain crops at recent price relationships. The investigation reported here is an attempt to examine critically that belief.[1]

The analysis deals with the effects on corn yields of certain land substitutes; emphasis is centered on fertilizer as the most obvious substitute. The analysis examines market data that reflect actual producer behavior, rather than extrapolating such behavior from experimental results.[2] Knowledge of errors made in such extrapolations is generally lacking. The analysis also presents two approaches to the hitherto unsolved problem of the effect of weather on production relations. One approach is to average out the effects by using long term (nine-year) average yields. The second is to account for weather by a constant term in a covariance analysis.

In attempting to solve the weather and extrapolation problems two new ones are introduced. By moving to actual behavior the data have been restricted to state averages, hence an aggregation problem. This problem is essentially ignored throughout. The results are presumed

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[1] The analysis in this paper is based on an unpublished Ph.D. dissertation of the same title submitted by the author to the Department of Economics, University of Chicago, 1959. The research was supported by the Conservation Foundation; they, of course, bear no responsibility for the findings reported here. The traditional (rightfully) list of acknowledgments appears in the original. In addition, the author would like to thank Professor D. Gale Johnson, with the usual disclaimer for responsibility, for criticism of this particular draft.

[2] Other studies have examined the same kind of aggregate data as analyzed in this study. One in particular, D. B. Ibach, *Substituting Fertilizer for Land in Growing Corn,* U. S. Dept. Agr., ARS 43-63, Nov. 1957, derives marginal returns for aggregate fertilizer-yield relations. There are some very important differences between that study and this one. In fact, direct comparison of the two is almost prohibited. The reference cited takes as given a relation between fertilizer and yield, and presents calculations of marginal returns for various application rates. The present study, on the other hand, attempts to estimate the relationship between several inputs and yield. A basic goal of this study is to explain changes in yield; therefore, the objective differs in many essentials from Ibach's. In addition to explaining yield changes, an attempt is made here to test the hypothesis mentioned in the first paragraph above, that less fertilizer is being applied than would be optimal given certain prices. The present study can then be placed in an empirical hypothesis testing framework, it is not designed to present specific alternative estimates to those found elsewhere, although in certain instances differences may appear.

relevant to average yields by states and not to any firm or set of firms.[3] By the same move a problem of identifying a production relation in a set of simultaneous equations is introduced. This problem is pursued in the next section. In Section III the cross section model with weather averaged out is presented. In Section IV the weather solution by covariance techniques is introduced.

II. *The Identification Problem*

Since Marschak and Andrews' 1944 paper[4] it has been recognized that with the ordinary set of assumptions the estimation of a cross section production relation involves a set of simultaneously determined relations. The problem of identification is not always considered in empirical studies of production relations. When producer behavior is introduced the identification problem must be solved before estimation can proceed. The problem for the specific context of this study is posed in this section along with the proposed criteria whereby identification is achieved.

Given a production relation:

$$Y_i = F(X_{i1}, \cdots X_{in}) \tag{1}$$

for the *i*th firm, competitive equilibrium requires that:

$$\frac{\partial F}{\partial X_{ij}} = \frac{P_j}{P_y} \tag{2}$$

therefore the decisions as to factor use in (2) are simultaneously determined. The usual model of firm maximizing behavior under static conditions explicitly assumes such determination. Unless such determination is taken into account for statistical estimation of a relation such as (1) a bias of unknown magnitude is implied for the parameters to be estimated.

For meaningful estimation it is ordinarily assumed that productivity coefficients in (1) are parameters for a group of firms and thus constant for those firms. Since the competitive model is used, all firms are pre-

[3] In view of the recent interest in aggregation theory it should be pointed out that the procedure does not fit neatly into the classifications used by Foote and Nerlove in *Analytical Tools for Measuring Demand and Price Structures*, Agr. Handbook No. 146, U. S. Dept. Agr., 1958. We have essentially fitted a micro theory to macro variables without formulating a macro theory. This results mainly from ignorance of the relevant weights, and average yields are presumed equivalent to average behavior of producers. This aspect of the problem restricts the discussion of the model in Section IV in some directions concerning expectations. In spite of this we have somewhat incautiously interpreted macro observation as equivalent to micro later on.

[4] Marschak and Andrews, "Random Simultaneous Equations and the Theory of Production," *Econometrica*, Vol. XII, July-Oct. 1944. An unpublished dissertation by I. Hoch, "Estimates of Agricultural Resource Productivities Combining Time Series and Cross Section Data," Univ. of Chicago, 1957, considers the problem at some length. One aspect is extended in his "Simultaneous Equation Bias in the Context of the Cobb-Douglas Production Function," *Econometrica*, Vol. XXVI, No. 4, Oct., 1958.

sumed to face the same market prices, P_j and P_y.[5] If we take a Cobb-Douglas form for (1):

$$Y_i = AX_{i1}^{b_1} \cdots X_{in}^{b_n} \tag{3}$$

find the relations (2):

$$\frac{\partial F}{\partial X_j} = \frac{b_j Y_i}{X_{ij}} = \frac{P_j}{P_v} \tag{2'}$$

and substitute X_{ij} from (2′) into (3), we obtain:

$$Y_i = A \prod_{j=1}^{n} \left(\frac{b_j Y_i P_v}{P_j} \right)^{b_j} \tag{4}$$

By the assumptions of the model, if observations were made on i firms we could expect no variability in the right hand side of (4) except through A, the constant term. However, we observe variability and must explain it.

If we just formulate the stochastic form of (3) by adding a residual u_i, we introduce an identification problem. If the stochastic form of (3) is:

$$Y_i = AX_{i1}^{b_1} \cdots X_{in}^{b_n} u_i \tag{3'}$$

then a linear combination of (3′) and any or all of the (2′) can be found that is indistinguishable in form from (3′). A solution is to consider the equation (2′) as also involving residual terms:

$$X_{ij} = \frac{b_j Y_i P_v}{P_j} + V_j$$

We are back in the simultaneous equation problem but we can now rationalize observed variation in X_{ij}, which we could not with (3) and (2′).

We seem to have come to an estimation impasse. There is, however, another set of assumptions that will preserve an approximation to the competitive model and yet allow least squares estimation of a relation such as (3). Assume that factor prices are known at the initiation of the production period but product prices are not. (This clearly is an acceptable assumption in the case of agricultural production.) Variations in X_{ij} can now take place; each firm's factor use will be a function of its price expectation. Since we are interested in observations of X_{ij} and not in estimation relations such as (2′), the estimation of (3) can take place directly without considering how the expectations are formed.[6] Each firm individually can be thought of as maximizing with respect to some ex-

[5] It would appear that varying prices would allow identification of the production function. If different prices do exist then observations should be made on prices, and price relationships should constitute the theoretical framework. A production relation such as (1) is then no longer useful.

[6] A problem of ex-ante equilibrium is introduced. The optima found later are all ex-post.

pected price. Each has a set of equations (2′) that need not be identical with other firms.

A second set of assumptions can yield the same result. If the productivity conditions are assumed subject to fluctuations then producers can be assumed to maximize with respect to expected productivity. The influence of weather in agricultural production could give such a result. This again would lead to variability in X_{ij}. Thus all producers can be assumed to have the same production function, but their expectations as to its shifts can differ.

In the analyses that follow the production relations will be assumed identified by one or both of the above assumptions. Least squares estimates are presumed to be valid as far as the independence of X_{ij} and u_i are concerned.[7]

III. *The Cross Section Model*

One solution to the weather problem is to average it out by considering long run average yields. This section utilizes such a method to derive estimates of the effects of certain inputs on corn yields for 31 states.[8] Two time periods were considered. Nine year centered averages of yields for 1950 and 1954 were regressed on a set of variables for those years.[9]

Initially the average yields were regressed on: (1) a basic productivity variable defined as the average yield, 1900-29, in each state; (2) the percentage planted to hybrids in 1950; (3) the difference in fertilizer use per acre of corn, 1930-1950. For the last variable it is assumed that fertilizer use in 1930 is associated with the basic productivity yield.[10] As

[7] It should be pointed out that another method which can be called the "ratio method" has been used by Klein, *A Textbook of Econometrics*, Row Peterson, 1953, pp. 193-196, and Wolfson, "An Econometric Investigation of Regional Differentials in American Agricultural Wages," *Econometrica*, Vol. XXVI, No. 2, April 1958. Under certain assumptions this method avoids the identification problem also. The productivities are derived from the geometric mean of observations in relations such as (2′) (after moving b_j to the left hand side). This is clearly superior in terms of computation ease, but by assumption must postulate that equilibrium holds ex-post and the average firm is optimal in the use of the factor. Since the assumptions underlying the V_j of (2′) will be essentially those of price or output expectations considered above, the fitting of the relation (3) without the optimality assumption of the ratio method would appear preferable for certain problems.

[8] These 31 were all states that planted 100,000 acres or more in corn in 1950 except for Montana and Colorado.

[9] The original analysis contained in Johnson, *op. cit.*, only contained the regression for 1950. Since then additional yield observations have made it possible to calculate the 1954 regression.

[10] Observations of fertilizer use per acre in 1950 are taken from Agr. Handbook 68, *Fertilizer Use and Crop Yields in the United States*, U. S. Dept. Agr., 1954. The observations for 1954 are from Stat. Bul. 216, *Fertilizer Used on Crops and Pasture, 1954 Estimates*, U. S. Dept. Agr., Aug. 1957. In each case the observation is derived from total acreage, not just acreage fertilized. The observations are in terms of pounds of total nutrients. Evidence in U. S. Dept. of Agr. Stat. Bul. 191, *Statistics*

might be expected, most of the variation in yield was associated with basic productivity, although the coefficients were significant at the 5 percent level. In addition, there was collinearity between basic yield and the other independent variables. To avoid these problems the yield variable was re-defined as average yield minus basic yield. This new variable was then regressed on the two variables specified above plus a mechanization variable and, in the 1950 regression, on acreage changes. The mechanization variable is less than ideal, being an allocation to states of Tostlebe's[11] constant-dollar-value figures for machinery and equipment by regions. The actual specification is the change in value, 1930 to 1950 and 1930 to 1954, per acre of corn, with weights derived from the value of corn relative to all crops.[12]

There is no a priori basis for specifying the direction of the acreage effect. The variable was originally included to try to catch any consistent bias in yields that would result from a shift in acreage weights. The effect was negligible and was not included in the 1954 regression.

Table 1 contains the estimated coefficients, standard errors, and elasticities at the means for the variables described above. We have independent checks from experimental data on the magnitudes of the hybrid and fertilizer coefficients, and these will be discussed before any optimality considerations are taken up. The mechanization coefficient is highly significant in both cases, but no really good independent checks exist for it, and its contribution will be ignored for the most part.

The estimates of the hybrid coefficient for the two years bracket the commonly accepted belief that hybridization would increase yields 15 to 20 percent.[13] The implication is that if acres went from 0 to 100 percent, average yields would increase somewhere between 15 and 20 percent. The coefficients in Table 1 imply an increase of 13.7 percent and 22.8 percent from complete hybridization.[14] From these results one might infer that the regression results for the aggregates used are plausible as far as hybridization is concerned.

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on Fertilizer and Liming Materials in the United States, April 1957, indicates that for the United States the proportion of all fertilizer going to corn stayed constant from 1930 to 1950. The 1930 use was then calculated by using 1950 weights on total state use in 1930.

[11] Tostlebe, *Capital in Agriculture,* Princeton Univ. Press, 1957.

[12] It is not obvious that mechanization is a land substitute over all points on a production surface. Some aspects, such as timing of operation, would tend to raise yields on a given acreage; these are the effects the mechanization variable should pick up.

[13] For sources of this statement see Zvi Griliches, "Hybrid Corn: An Exploration in the Economics of Technological Change," *Econometrica,* Vol. 25, Oct. 1957.

[14] These estimates are derived as follows: The coefficient for 1950 indicates a 3.47 bushel increase in yield over the basic yield from 100 percent hybrid (0.347 times 100). This increase as a percentage of the mean basic yield of 25.3 bushels is 13.7. A similar computation for the 1954 regression gives a percentage of 22.8.

TABLE 1. COEFFICIENTS, STANDARD ERRORS, AND ELASTICITIES ESTIMATED FROM THE REGRESSION OF STATE AVERAGE YIELDS MINUS BASIC PRODUCTIVITY YIELD ON FERTILIZER, HYBRIDIZATION, MECHANIZATION, AND ACREAGE

Year and Item	Variable				R^2
	Fertilizer	Hybridization	Mechanization	Acreage	
1950					
Coefficient	.152	.0347	.491	.000085	.71
Standard Error	.0408	.0248	.131	.0243	
Elasticity at Means	.089	.073	.114	.002	
1954					
Coefficient	.0908	.0578	.628	—	.73
Standard Error	.0296	.0497	.1857	—	
Elasticity at Means	.123	.129	.151	—	

Note: Fertilizer is measured in lbs. of nutrients, hybridization in percentage of acres in hybrid, mechanization in dollars per acre.

For the fertilizer coefficients a useful check exists in the unique summarization and collation of experimental results up to 1950 contained in Agricultural Handbook 68 (*op. cit.*). These data were compiled by the various states by summarizing experimental results regardless of time and location. The results should provide the best expectation in terms of experimental results of the relevant state average productivity from fertilizer application. The results are reported as percentage changes in yield expected from given percentage changes in the three primary nutrients. When weighted by 1950 nutrient use these estimates will provide elasticities that are comparable to those in Table 1.[15]

In Section IV a breakdown into Corn Belt and Southern Regions will be made. From the regression model the fertilizer coefficient is constant, but elasticities for various levels can be computed. Making the same Corn Belt-Southern breakdown as later we can derive elasticities for the regions. The elasticities are compared in Table 2.

The agreement with experimental results for fertilizer, or for hybridization, does not appear unreasonable.[16] With this external check on validity the results can now be examined in terms of optimal use.

[15] Note that this procedure rests on the same implicit hypothesis as the rest of this analysis, that over the range of observations contained herein the three nutrients are perfect substitutes (pound for pound). At the relatively low levels involved this assumption would not appear to be too strong.

[16] Predicted yield figures in bushels from Handbook 68 imply a higher marginal productivity than those reported here. The main point is that one measure of experimental response (percentage change) is not different enough to cast serious doubt on the parameter estimates in Table 1. The price considerations depend on productivities and not elasticities so that some assumptions would have to be made before the Handbook 68 figures were comparable over-all.

TABLE 2. REGIONAL ESTIMATES OF PRODUCTION ELASTICITIES FOR FERTILIZER FROM THE 1950 AND 1954 REGRESSIONS AND FROM AGRICULTURAL HANDBOOK 68

Source	Elasticities		
	United States	Corn Belt	South
Handbook 68	—	.076	.24
1950 Regression	.089	.074	.16
1954 Regression	.123	.089	.18

In Table 3 are presented ratios of the price of fertilizer to lagged product price, as well as to product price of the same year. The competitive equilibrium condition would imply that the marginal productivity of the factor would equal the price ratio. The price ratio here is not proper. Strictly speaking, the correct product price is the expected price.[17] If this were known, an ex-ante equilibrium could be found. The previous year's product price will be taken to approximate such a price.

It should be noted that the fertilizer price is a weighted average price for the three primary nutrients. On the assumption of perfect substitutability of the nutrients the same marginal productivity can be compared to regional prices, where the difference in weighting gives slightly different prices.

A comparison of the appropriate fertilizer coefficient in Table 1 with the price ratios in Table 3 indicates a large divergence between the price ratio and the marginal productivity for fertilizer in 1950. For 1954, however, the divergence is not nearly so large. It would appear that there was a substantial movement towards equilibrium in the fertilizer-corn relationship between 1950 and 1954.

The above findings call for further investigation. We have found pro-

TABLE 3. PRICE RATIOS FOR FERTILIZER AND CORN[a]

Region and Ratio	1950	1954
United States		
Price of fertilizer/lagged price of corn	.077	.063
Price of fertilizer/price of corn	.063	.066
Corn Belt		
Price of fertilizer/lagged price of corn	.064	.058
Price of fertilizer/price of corn	.054	.067
South		
Price of fertilizer/lagged price of corn	.083	.072
Price of fertilizer/price of corn	.097	.070

[a] Fertilizer prices are weighted average prices of the three nutrients as derived from *Statistics on Fertilizer and Liming Materials*, U. S. Dept. Agr. Stat. Bul. 191, April 1957. Corn prices are weighted average prices as officially reported.

[17] This, of course, follows directly from the identification discussion in Section II. The empirical as well as theoretical problem of expected prices is treated by M. Nerlove in "Estimates of the Elasticities of Supply of Selected Agricultural Commodities," *J. Farm Econ.*, 38:496-509, May 1956, and in his later writings.

ductivity coefficients surprisingly close to experimental estimates, but the hypothesis of a "large" disequilibrium in fertilizer use would have to be rejected in the 1954 case. We have included observations from states with widely different initial use of fertilizer. If observations could be made on a regional basis so that knowledge of techniques, real prices, etc., would not be so large an unknown factor, more light might be shed on the question of disequilibrium. The model in the next section is designed not only to give a regional breakdown, but to give annual observations also. The weather problem still intrudes, and the model attempts to control it also.

IV. *The Co-variance Model*

The model used in this section appears to be one that is ideally suited to investigation of the yield problem—a linear co-variance model.[18]

If the usual least squares assumptions are met this model will allow us to combine time series and cross section observations. In addition, if two assumptions to be introduced presently hold we can account for weather effects on the annual yield variations.

Letting small letters refer to logarithms of the variables, we assume the following production relation:

$$y_{st} = a + c_s + d_t + b_1 x_{1st} + \cdots + b_n x_{nst} + u_{st} \tag{5}$$

Here, y is yield, x_i ($i = 1, \ldots, n$) are a set of inputs, the index s refers to states, the index t to years. Equation (5) states that y_{st} is equal to the sum of an over-all constant, plus a state constant for state s, plus a year constant for year t, plus b_1 times the value of x_1 for state s and year t, . . ., plus b_n times the value of x_n for state s and year t, plus a disturbance. Thus the yield for state one in year one can be written as:

$$y_{11} = a + c_1 + d_1 + \sum_{i=1}^{n} b_i x_{i_{11}} + u_{11} \tag{6}$$

The estimates of the parameters, $\hat{a}$, $\hat{c}_s$, d_t, $\hat{b}_i$ can be found by least squares regression procedures.

The interpretation that can be given the constant terms is the factor that makes the co-variance model useful for the present problem. The basic assumption is that there are differences in mean yields between states and between years that are not due to the independent variables. The state constant is assumed the same for each state over all years, and the year constant is assumed the same for each year over all the states. Based on these assumptions the constant terms are given a specific interpretation in the present context. The state constant c_s is assumed to re-

[18] For the use of a co-variance model in a production setting see I. Hoch, unpub. diss. (*op. cit.*). A more general model of combining cross section and time series observations for estimating economic relationships was presented by C. Hildreth in "Combining Cross Section Data and Time Series," unpub. Cowles Comm. disc. paper, No. Stat. 347, May 1950.

flect basic productivity in each state considered. The year constant is assumed to reflect weather effects in each year. An alternative interpretation is that the effect of the independent variables has been estimated for yields that are "corrected" for weather and basic productivity.

To associate weather directly with the year constants, then, weather effects must operate uniformly over any group of states chosen. Fortunately, some rough tests of hypotheses in this area can be made.

It is first assumed that there is a broad complex of factors that might be called weather that no simple variable can define. A plausible way to deal with weather is to take as evidence of similarity in weather the movement of yields in the same direction with roughly the same magnitude for a series of years for a group of states. Since regions can be identified on other grounds, it was only necessary to define such regions and test the rankings of yields within those regions over a series of years. If significant agreement is found it will be assumed that any year can be ranked weather-wise for the entire region.

This agreement can be found by computing a statistic—the coefficient of concordance—which indicates the degree of agreement among a group of rankers.[19] This statistic can take values from 0 (complete randomness) to 1 (complete agreement). Further, the difference between the coefficient and zero agreement can be tested. In this present formulation a choice is still involved. Inclusion or exclusion of peripheral states may raise or lower the coefficient without violating a specified significance level. A more or less optimal weather-defined region can be found. The results are not reproduced in full here. Six midwestern states (hereafter somewhat incorrectly referred to as the Corn Belt), Ohio, Indiana, Illinois, Michigan, Wisconsin, and Minnesota, comprise a homogeneous weather group on the basis of the proposed test. Also, six southern states, Virginia, North Carolina, South Carolina, Georgia, Alabama, and Mississippi, comprise such a set.[20] These two regions are the ones included in the study.

As mentioned earlier, another variable which cannot be specified exactly in this aggregate setting is shifts in acreage. Inspection of the changes in total acreage in corn states would indicate that the above two regions (as well as others) are also homogeneous with respect to acreage shifts.[21]

With the above framework, regressions were made of state average

[19] Due to Kendall; see M. G. Kendall and B. B. Smith, "The Problem of *m* Rankings," *Ann. Math. Stat.*, XII, 1937, pp. 275-87.

[20] For the years included in the study, 1947-54, the coefficients and F-tests for these two groups were: Corn Belt, .720 (12.86) and South, .657 (9.58).

[21] Some calculations on within-state variability for Illinois indicate that any bias in average yield figures over time due to shifting weights has not been upward—that is, reported average yields have not shown a spurious increase. Unfortunately, data were not available to make calculations for all states in this manner. A generalization to the Corn Belt might not be too dangerous.

TABLE 4. REGRESSION OF STATE AVERAGE CORN YIELDS ON FERTILIZER, HYBRIDIZATION, AND MECHANIZATION USING COMBINED TIME SERIES AND CROSS SECTION DATA (ALL VARIABLES IN LOGARITHMS)

	Coefficient and Standard Error			R^2[b]	Proportion of Total "Explained" Variation That is Explained by X_1, X_2, and X_3	F-Value for Testing Significance of State and Year Constants	
	Fertilizer X_1	Hybrid X_2	Mechanization X_3			State	Year
Corn Belt[a]							
Ordinary Least Squares	.0559 (.0369)	2.08 (.557)	.0831 (.0970)	.47	all		
Time-correction only	.0682 (.0394)	1.738 (.689)	−.0486 (.220)	.76	.29		6.45**
Analysis of covariance	.0663 (.103)	.0558 (1.55)	.576 (.501)	.82	.02	2.08*	7.26**
South[a]							
Ordinary Least Squares	−.0780 (.202)	.0241 (.156)	.345 (.264)	.21	all		
Time-correction only	.184 (.102)	.117 (.772)	.596 (.173)	.88	.85		27.48**
Analysis of covariance	−.0756 (.136)	.0782 (.0838)	.189 (.419)	.92	.04	2.42*	5.32**

* Significant at .10 level.
** Significant at .01 level.
[a] Corn Belt: Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota. South: Virginia, North Carolina, South Carolina, Georgia, Alabama, and Mississippi.

[b] In all cases R^2 is $1 - \dfrac{\text{unexplained variation}}{\text{total variation}}$

yields by years and states within regions for 1947-54. The results are presented in Table 4. All variables were in logarithms. The fertilizer variable is in terms of plant nutrients per acre, the hybridization variable is percentage acres planted to hybrids, and mechanization is a weighted average of tractors and corn pickers.[22]

Three different regressions for each region are shown in Table 4: an ordinary regression on the three independant variables, the analysis of co-variance for both states and years, and what is referred to here as the "time correction only" model. The latter is similar to the co-variance model except that only a year constant is generated.

It is quite evident from Table 4 that in the Corn Belt the explanatory power of the model is in the constant terms. A large increase in the explanation is achieved by their inclusion, but the explanatory effect of the independant variables is not increased.

At this point the hybridization and mechanization variables will be ignored; substantive conclusions are made for the fertilizer variable only. In terms of standard errors, the estimates of the fertilizer coefficients in Table 4 are not particularly good. One of the contributions of this paper is considered to be an exposition of a method of analysis. For that purpose the low significance levels do not matter too much. Since the results are analyzed for their empirical content, it should be pointed out that certain of the coefficients under consideration are consistent with those found in Section III, and are in a range of magnitudes one would expect. The co-variance coefficient for the Corn Belt and the time-correction-only coefficient for the Southern region will accordingly be accepted as "good" estimates.

Continuing the assumptions of Section II, it is now assumed that producers do not use fertilizer up to the point that maximizes returns in accordance with ideal weather. Rather, they maximize with respect to average weather. From the model we can adjust any year's yield (and marginal productivity) to an average weather basis by dividing by D_t (the unlogged value of d_t). The marginal productivity that would be equated to a price ratio is not

$$\frac{b_1 Y_t}{X_{1t}}, \quad \text{but} \quad \frac{b_1 Y_t}{D_t X_{1t}}.^{23}$$

[22] The fertilizer observations are based on reported total state use and are allocated to corn by using 1950 weights for 1947-51, and 1954 weights for 1953-54; 1952 uses a simple average of the two estimates. The weighting procedure is not simply proportional for each year, it attempts to account for acreage shifts also. Thus, for a single nutrient in any year it is assumed that the ratio of nutrient per acre devoted to corn or other crops for a year to be calculated is equal to the same ratio for the year of known weights.

[23] It is at this point that micro observations could be used to test a micro-theory of maximization with respect to "expected" marginal productivity; see footnote 3, above.

TABLE 5. PRICE RATIO, UNADJUSTED AND ADJUSTED MARGINAL PRODUCTIVITIES, IMPLIED EQUILIBRIUM AND ACTUAL USE OF FERTILIZER, 1949–54

Year	Ratio $\frac{P_F}{P_{c,t-1}}$	MP[a]	Implied Equil. Use Fert. (lbs./acre)	Adj. MP[b]	Implied Equil. Use (lbs./acre)	Actual Use
			Corn Belt			
1949	.071	.162	46.7	.141	40.4	20.4
1950	.064	.118	46.7	.127	50.2	25.3
1951	.052	.113	59.9	.123	64.8	27.5
1952	.054	.096	65.3	.097	66.4	36.9
1953	.058	.071	58.9	.077	64.5	48.4
1954	.058	.066	60.4	.073	66.5	52.7
			South			
1949	.084	.099	52.1	.073	38.7	44.3
1950	.083	.087	56.5	.070	45.1	53.9
1951	.073	.080	60.2	.080	60.5	55.2
1952	.065	.044	49.3	.070	78.4	73.0
1953	.064	.051	66.1	.070	91.0	83.7
1954	.072	.033	42.7	.067	85.7	92.2

[a] $MP = \frac{\partial Y}{\partial X} = \frac{\hat{b}_1 Y_t}{X_{1t}}$

[b] Adj. $MP = \frac{\partial Y}{\partial X_i} \frac{1}{D_t} = \frac{\hat{b}_1 Y_t}{D_t X_{1t}}$

Marginal productivities for fertilizer, computed at the mean values of fertilizer use and yield, are shown in Table 5, along with the price ratio of fertilizer to lagged corn price. Both the adjusted and unadjusted productivities are shown.[24]

If the price ratio used is correct the use of fertilizer implied from the adjusted marginal productivity is closer to actual use. This is especially true for the Southern region, where the apparent disequilibrium practically disappears. For the Corn Belt both productivities imply a use below the optimum. The only positive statement in the latter case is that the movement was in the right direction.

One of the less fortunate aspects of the model is that the constants are generated internally, so to speak, so that testing the model with new observations is not particularly feasible.[25]

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[24] The price ratio under the assumption of Section II should be the expected price of corn. The price used here is taken to approximate such a price. Both sides of the implied micro model could now be formulated. Equate expected price to expected marginal product. This condition originally formed the basis for the model in the text which it is assumed to approximate.

[25] One way would be to assume zero disturbances and calculate a new year constant using the b-values already found. Two things prevented such a calculation. One, the poor results (in terms of significance) already cast some doubt on the precision of the model. Secondly, one would want some kind of check on the magnitude of the constant found. It is not clear what would constitute such a check.

V. *Conclusions*

Estimates of productivities of certain land substitutes have been made using two different models. In addition, the question of the existence of a large divergence between the value of the marginal product of fertilizer with respect to corn and the price of fertilizer has been considered. The results must be considered tentative in view of the statistical measures of accuracy, and in view of their contradiction of estimates found elsewhere. The results, then, are subject to further test. However, the tentative evidence is that for the Southern region the divergence may not be very large, and that for the Corn Belt the annual movements from 1949 through 1954 were all in the direction of a narrowing of the gap.

Several things must be kept in mind concerning the above results. It takes no insight beyond a first course in economics to predict the elimination of any substantial gap between the marginal productivity of a factor and its price. However, it is only when the weather effect is controlled that one can verify empirically that such a gap ever exists or is being closed if it does. The attempts to handle the weather effects and still derive satisfactory estimates would seem to be the most significant part of the analysis.

FARM TENURE PERSPECTIVE OF VERTICAL INTEGRATION

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INTEGRATION of farm activities with those of other firms is rapidly gaining importance as an institution affecting agriculture. The character of the contractual arrangements incident to integration raises new farm tenure problems. For one thing, the programs of vertical integration constitute economic reorganizations in which the ownership interests in farm resources and the control over these resources may be redistributed. From another aspect, such farm tenure circumstances as leasing may serve either as restraints to or as factors conducive to the adoption and expansion of integration programs. Because of these two aspects—the impact of integration on tenure relationships on the one hand, and the tenure-related conditions that affect entry into integration contracts on the other —vertical integration in agriculture presents a "two-phased" problem in the analysis of farm tenure.

Even though these problems are recognized, they are emphasized relatively little in the literature on vertical integration.[1] They should be particularly important, however, for those concerned with questions of farm tenure. Hence, the main purpose of the discussion that follows is to set forth some general propositions on vertical integration from a farm tenure viewpoint.

The tenure-related conditions that may influence farmers' entry into integration are first examined. Next, the nature of farm tenure relationships under integrated organizations is discussed. Considering the multiplicity of integration programs and the variations in the types of contractual arrrangements that have emerged, only broad generalizations can be made here. Appropriate refinements and qualifications will be necessary for specific applications.[2]

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* The author benefited from the comments of Drs. Gene Wunderlich and Howard Ottoson on an earlier draft of this article.

[1] *Cf.* U. S. Department of Agriculture, *Contract Farming and Vertical Integration: A Selected List of References*, Library List No. 64, June 1958; Supplementary List of References For the Period May 1958 to Aug. 1959, Unpublished.

Available published papers that are directly oriented to integration and farm tenure are as follows: Raymond J. Penn, "Tenure Innovations and Tenure Problems Associated with Vertical Integration," *J. Farm Econ.*, Dec. 1958, pp. 1383-1390; Discussion by Marshall Harris, *Ibid.*, pp. 1390-1392. The subject is discussed implicitly by Earl Butz, "Social and Political Implications of Integration," *Feedstuffs*, April 25, 1959.

[2] A program in which the vertically integrated organization is under a single owner, or is a cooperative, or in which the integrator (a supplier, a processor, or a marketer) does not clearly cause further division of farm tenure rights, would not fall within the present frame of reference.

Tenure-Related Conditions and Entry into Integration

Conceivably, conditions related to the tenure status of farmers can either restrain or encourage their entry into integration. These tenure-related conditions are discussed here under the headings adequacy of resources and risk bearing. Presumably, an owner operator who has an adequate combination and quantity of resources, including management, and the capacity or willingness to withstand the consequences of his decisions will have little or no incentive to enter into integration contracts. This cannot be said for farmers in other tenure categories or subclasses. How may the farmers who are most likely to become integrated be identified? This may entail examining the characteristics, motivations, and possible behavior of landlords as well as of owner operators and tenants operating under various circumstances.

Adequacy of resources

The importance of the resources—capital and management—contributed by integrators is presumably one reason why some farms become integrated. Farms that are most likely to become integrated for this reason are those in which the productivity of land or labor or both are relatively low as a result of restricted capital or inferior management or both. To the extent that these conditions are associated with tenure groups, we might predict that farmers in the younger age groups—particularly owner operators—will find the opportunities offered by contracting firms, whether suppliers or processors, most appealing. Those are the farmers who are more often limited in the resources that are usually furnished by integrators. Their entry into vertical integration would not only improve the organization of their resources; it would also increase the quantity of resources used and thus the income-earning potentials of their farms.[3]

Older owner operators may enter into integration contracts for different reasons—simply to divest themselves of certain management responsibilities or to maintain the income levels they desire or both. However, the preference of integrators for farmers with little experience, to whom they might dictate managerial practices, should tend to hold down the number of older operators entering into integration.

Tenants also will enter into contracts, but entries might be expected

[3] From the standpoint of farm resources furnished under vertical integration, there is essentially no difference between the basic reason for entering leasing contracts and that for entering integrating contracts. Both motivations and purposes are similar—limited resources of different owners are pooled for farm production. In addition, integrating contracts are formally analogous to leasing contracts in the sense that they specify the purposes of association, indicate the contributions, prescribe the duties and responsibilities of the parties, and so on. Furthermore, there may be unwritten provisions as in leases.

to be less frequent than those of full-owner operators within a comparable age group. This is true because usually, other things being equal, the tenant-operator farms (and those of part owners too) are not as short on capital as are owner-operator farms. Furthermore, the entry of tenant operators into integration is more difficult than is entry of owner operators because multilateral arrangements are required.[4]

Notwithstanding the complexity of entry into the integrating arrangements required for rented farms, some landlords prefer renters who produce under integration contracts. One might suspect that, apart from the attitude toward risks, the desire of these landlords to have contracts for their products is due partly to the limited time they have available to participate in the farm's management or to their incapacity to take an active part in such management. The influence of such landlords upon entry into contracts clearly depends, however, upon the conditions of the rental market for land, including the preferences of tenants and their bargaining position.

Beginning, part-time, and low-income farmers should find integration attractive as a means of improving management and increasing capital. These groups of farmers are not traditional tenure classes. But they do need to be singled out as special subclasses on the basis of the amount of resources they control. In evaluating tenure-related conditions that affect entry into contracts these groups can become significant variables.

Risk bearing

It may be well to emphasize that theoretically the minimization of risks can be overrated as a reason for farmers' entry into vertical integration contracts.[5] The risks directly affected under the contracts in most prevalent use usually pertain largely to factor or product prices and markets for one production period. Contracts on prices are means of shifting the incidence of risks. In one form or another these are common, but they are not unique, features of integration contracts. Farm output and prices may become less unstable because of changes in the time distribution of

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[4] On rented farms, integration sometimes calls for multilateral arrangements that involve a supplier, an operator, a landlord, and a processor. (On owner-operator farms, landlords are not involved.) More frequently, however, only trilateral arrangements are required on rented farms and bilateral arrangements on owner-operator farms, because either the supplier or the processor is excluded or they represent one and the same firm. The main point here is that the difficulties in arriving at arrangements increase more than proportionately with the increase in the number of parties to a contract. The number of "agreements" required might follow a progression such as $N(N-1)$, in which $N > 1$ represents the number of contracting parties.

[5] This question is discussed by Martin A. Abrahamsen, "Agricultural Integration: Some Further Considerations," in *Cooperatives and Agricultural Integration*, Farmer Cooperative Service, U. S. Dept. Agr., August 1959.

production and in cultural practices introduced by integrators. But this still leaves uncovered the hazard of uncertainties arising from general business cycles. In addition, the uncertainties that stem from technological changes or some natural phenomena are not reduced except to the extent that some form of diversification or flexibility is introduced incidentally into the farm organization.

The procurement of some productive factors or the disposal of products is ordinarily more secure and some uncertainties of production are presumably shared under integration. But equally important from the viewpoint of the farmer is the uncertainty as to renewal of a contract or as to how much product will be taken if the contract is renewed. These considerations become especially relevant if the contracted enterprise requires major changes in farm organization for which specialized buildings, machinery, or equipment are needed. The fear that a contract might not be renewed from one period to the next could make a farmer's relationship with respect to future control over his resources insecure or his bargaining position inferior. These unfavorable prospects might discourage farmers from integrating their activities with those of other firms. Furthermore, farmers with relatively short or uncertain expectations of occupancy may refrain from entering into contracts if the integrating arrangements require major reorganizational outlays on their part or farming practices from which the accrual of all returns is not coterminous with their expected period of occupancy.

One may anticipate, however, that some share landlords and tenants might be influenced by the reduction or division of risks that usually accompany integration. With contract prices and less insecure factor or products markets, these individuals will likely prefer to enter into contracts rather than to stay out. In effect, the risks inherent in future prices or markets (for the immediate production interval) are virtually removed and the fact of this removal is important to them. Problems of entry become aggravated, however, when a share landlord and his tenant differ considerably in their expectations as to the prices they would receive if they did not enter into integration contracts, or when new expenditures are required of either of them.

As the risks faced by renters differ according to type of lease, one can expect that, in view of the forward price feature, fixed-cash renters would have more incentive than would share renters to enter into integration contracts. With contract prices, the uncertainties of meeting fixed rental payments from expected income are moderated. In addition to the risk-reducing influences, cash renters ordinarily have greater freedom to make production, marketing, or financing decisions than do other classes of tenants. Except for liens, landlords of cash renters, as opposed to those

of share renters, will ordinarily play a relatively minor role in the decisions to enter into integration contracts. This makes the entry into integration less encumbered under cash leases.[6]

Farm Tenure Under Integrated Organizations

For convenience, the effects of integration on farm tenure may be thrown into two broad categories: (1) Those changes that occur in the ownership interests in farm resources and the correlated rights to receive income from them and (2) those changes that occur in the dispersion of farming decisions between resource contributors.

Ownership interests and division of income

In preceding parts of this discussion, it was suggested that integration carries with it the opportunities for increasing capital inputs and improving management. Accordingly, it was argued that the aggregate quantity of resources per farm, as well as the income to be divided per farm, would also increase.

It follows that one farm-tenure characteristic that should be affected is the distribution of farm size, whether the measurement is made in terms of gross input or output. As farmers with inadequate resources are more likely to enter into contracts, the frequency distribution of farm size would be altered among the types of farms affected, or within areas where integration becomes important. This effect may be called immediate. But in the longer run, there is also the possibility that "integrated farmers" who in effect represent a new farm tenure class or subclass may have greater opportunity to expand their farm resources because of improved income and financial position. Accordingly, we might expect to see changes in the rates of growth of integrated farms and differences between these rates and those for previously comparable but nonintegrated farms.

The increases in resources brought about by changes in the number of resource contributors, whether they use methods of advance payment or credit or furnish management, are necessarily accompanied by further complexities as to liens, survivorship, and division of income. Liens and survivorship are important tenure questions as the distribution of rights between the contracting parties are affected by them; but they are largely legal matters. From the viewpoint of economic analysis, the more important questions are concerned with the distribution of income.

Perhaps we can accept an old principle that each contributor to a farm

[6] Changes in type of lease may occur in order to facilitate entry into integration. Cognizance must be taken of this possibility if the objective of an analysis is to determine changes or effects rather than causes.

business should receive the returns that are functionally related to his contributions. The questions faced are analogous to those of equity raised in devising leasing arrangements. But both the theoretical and the practical problems of evaluation are staggering. Particularly, the managerial services of the contractor must be compensated for in some way. Presumably, under integrating arrangements (in contrast to leasing) integrators are "compensated" for the services they contribute through the payments made to farmers for the contracted products, or through the prices charged for the factors they supply.[7] To the extent that this is true, these payments are very important in the analysis of farm tenure and integration. The determination of fair payments represents an important unsolved difficulty. In some instances, these payments are still being made on an experimental basis.[8]

Additional questions concerning ownership interests and division of income will necessarily be raised for rented farms because of the positive relationship between the number of parties to a contract and the number of reciprocal agreements that must be made. For a contract between a single-integrator firm and an owner-operator firm, the problems of agreement are relatively simple. But at the other extreme, where agreements between a supplier, an operator, a landlord, and a processor are required, the integrating arrangements become increasingly complex. Most important, new considerations are introduced in determining and agreeing upon what are fair rents.

Assuming an effective demand for contracts and an upward shift in the marginal productivity function for land through integration activities, rental rates should increase. The increased marginal product of land may represent a temporary gain to cash tenants until some new equilibrium rent is established. Changes in the structure of cash rents may then be observed as a consequence of integration. For share rents there is no obvious reason why the rates should change. Changes may occur, however, in the method of rental payment if the expected value of rent per acre differs substantially between types of leases because of the integration.

So far as integration becomes widespread for a product in certain areas, other conditions of leasing may be affected. For some farm leases their renewal or continuation may be made contingent upon obtaining a contract. Having a contract may become an important consideration for a landlord in selecting a suitable tenant, and vice versa, because of the role played by integrators in giving technical assistance and in risk bear-

[7] Interest is often charged on advances made by contractors for resources—fertilizer, seeds, feeds, and so on.

[8] Baker, Ralph L. *Integrating Egg Production and Marketing*, U. S. Dept. Agr. Marketing Research Rept. 332, June 1959, p. 33.

ing. Concomitantly, lease requirements as to some farming practices may be made to accommodate the requirements of integration contracts.

In addition, the fear of losing, or the desire to obtain, a reliable contract with which a substantial share of farm income is associated, may have a marked relationship to the mobility of farm operators. This point is particularly relevant if the integration contract is tied to land or if the product requires special locations. The possibilities of these effects are increased if the market for the contracted product becomes highly imperfect.[9]

There is little doubt that if changes occur in the structure of rental rates, parallel changes in land values will be observed. These changes will affect the opportunities to acquire or expand farms through ownership. Although entry into contracts may help young farmers to retire mortgage indebtedness, the increased land values engendered by integration may make buying more difficult for others. Moreover, the entry of some integrators into farm production through owning or renting land may have localized effects on the competition for and the nature of the demand for land to buy or rent.

Farming decisions

Vertical integration results in an organization characterized by changes in the decision-making environment of the farmers involved. These changes seem to be in two dimensions: Some types of decisions—organizational, operational, financing and marketing—are shifted from the farm operator to the integrator; others are shared between them.[10] In addition, the decision-making functions of coordinating and supervising farm operations become diffused, especially for rented farms. One might argue that a farmer is relieved of some of the burdens of management and that management of the farm is probably improved because an integrator is usually more specialized and encourages the use of more up-to-date techniques.[11] But equally significant from the farm tenure viewpoint are the associated changes in the tenure status of the operator.

Vertical integration would seem to call for redefinition of the tenure

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[9] The power of an integrator as a monopsony or as a colluding oligopsony, however, is likely to be counterbalanced eventually by the emergence of a growers' or producers' association.

[10] The decisions that are usually shifted are for the most part "organizational." They include decisions pertaining to such questions as what and how much to produce and what equipment or how much of a resource to use. Operational decisions are either shifted or shared. They involve answers to such questions as when to seed or farrow and when to harvest. Decisions as to where and when to sell the contracted product are removed from a farmer once he enters into a contract.

[11] Even though the decisions in question are usually confined to the contracted product, they may have some "side effects"; that is, they may affect other phases of the farm business.

status of some farmers because of the dispersion of the rights to make farming decisions.[12] For example, the ownership (or rental) and management of farmland (or farms) by integrators for producing the raw material they need tends to create entirely new tenure statuses for persons who operate these farms. Those individuals may, but need not, be managers in the true sense of the word; neither are they tenants or owners. Some are perhaps more accurately "contracted-hired-laborer-operators," who might be regarded as having extremely limited tenure rights as compared with "independent-debt-free-owner-operators." Similarly, instances in which an operator owns or rents his farm but is virtually hired to attend to a contracted enterprise imply changes in his tenure status. This kind of operatorship constitutes another form of departure from the traditional institution of "owner-manager-operator" as one person.[13] Even in the more typical instances in which only some types of decisions are affected, the tenure of the operators is changed because they have given up some independence.

Farmers who operate under these various conditions of integration presumably will differ as to incentives and effectiveness in the operation of the respective farms. The types of managerial decisions are shifted or shared differently, and ownership and management are separated in various degrees. Furthermore, farmers within the various integration programs will be in varying bargaining positions as to division of income from the farm resources.

Even though under integration a farmer may surrender voluntarily a part of his right to make independent farming decisions, conflicts between him and an integrator can ensue because each still seeks to maximize his own interests.[14] These conflicts are likely because of the dispersion of the coordinating and supervising functions of management. Formulating expectations and planning are taken over partly by contracting firms, while the farm operator implements plans and makes day-to-day decisions; yet he may still bear the main consequences of the action taken. Implicit in these circumstances is the imposition of inflexibilities in imple-

[12] Harris, *op. cit.*, p. 1392, has stated cogently, "Ownership and operatorship, key tenure concepts, may take on entirely different meanings [under vertical integration]. We will need to distinguish the integrated owner or operator from his nonintegrated distant cousin. From the standpoint of management and risks, the new tenure status may be dubbed 'disintegrated' owner or operator. For, in fact, these tenure statuses as we know them will have disintegrated in whole or in part."

[13] *Cf.* Butz, *op. cit.*

[14] A processor-integrator, for example, might aim at running his plant steadily at a given capacity, while the integrated farmer might prefer to harvest at a given time the product needed as raw material by the processing plant. Clearly, there is a likelihood of conflict between the integrator and the farmer as to the time of harvesting or marketing a contracted product.

menting farm plans and impairment of opportunities to make decisions. Occasionally, the right to make decisions becomes crucial for a farmer who sees the necessity of making unexpected changes in order to maximize either the use of his farm resources, his personal income, or some other end.[15] Besides, imbalances in the incidence of the farming decisions occur if the party who makes a decision does not take its consequences. Quite likely, the probability of conflicts or imbalances in farming decisions decreases with experience. Yet the importance of reconciling or adjusting them remains because the viability of integration depends considerably upon inter-personal relationships.

Provisions regarding noncompliance with the terms of the contracts raise further questions as to the nature and distribution of rights and duties between the parties concerned. Particularly in the absence of growers' associations or of managerial astuteness on the part of farmers, one should not be surprised to find that in some instances conditions favor the integrator rather than the farmer.[16]

Research Implications

The subject of integration in agriculture has innumerable facets. Therefore, those interested in it will no doubt attack the questions involved from different angles. Some may be especially interested in the market forms generated by the integration processes, others in the production efficiency or the legal perspectives, and so on. Although the different viewpoints are not mutually exclusive, that of farm tenure is especially important. Integrating arrangements can eventually become significant elements of the farm tenure system just as are leasing arrangements or other tenure characteristics. Although such developments may be of most interest to researchers who deal with farm tenure problems *per se*, they may serve also as constraints in some research undertakings on problems in finance, farm management, and others.

In view of current confusion, further conceptual work on contract farming in general from a farm tenure perspective might well be directed toward identifying those organizations that can be truly called integrated. Acceptable criteria for identifying them need to be developed and these could be centered around the distribution of the farm tenure rights.

[15] The types of situations in mind include harvesting to avoid bad weather, shifts in the timing of activities with respect to different enterprises, or reallocation of labor between products. The operator's preferences may be in conflict with the prescriptions or the preferences of the contracting firm(s). The problem would be worsened progressively by increases in the number of items a farmer produces under contracts that contain stipulations affecting management.

[16] A packing corporation, for example, holds mortgages (with the corollary rights) on all crops grown on the farms of the contracting farmers when advances are made with respect to the contracted product.

Empirically, work dealing with the conditions and relationships of farm tenure will be incomplete if integrating arrangements are excluded. For it is clear that these arrangements impinge upon the tenure rights of farm operators. The American farm tenure system may be modified greatly if vertical integration becomes widespread. Studies are needed to detect the effects of integration in its various forms upon the ownership and control of farm resources, and to indicate or develop the types of integrating arrangements that are fair in terms of the distribution of farm income.

Despite the belief by some that integration is in many respects inimical to the welfare of agriculture because it impairs the tenure status of farmers, entry into integration contracts has been increasing and may be desirable under certain circumstances. The gains may outweigh the disadvantages. Factors that affect the adoption and expansion of integration need to be identified. Studies oriented accordingly should therefore consider the tenure-related conditions that affect both entry into integration contracts and their execution.

THE INFLUENCE OF "IMPULSE BUYING" OR IN-THE-STORE DECISIONS ON CONSUMERS' FOOD PURCHASES[*]

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THE purpose of this study was to estimate the influence of "impulse buying" or in-the-store decisions on (1) total food expenditures and (2) the allocation of expenditures among particular foods and food groups.

The basic findings of this study may be summarized as follows:

1. A comparison between anticipated and actual food purchases for a week by individual families showed that less than half of the purchases actually made were anticipated. This indicates that a large percentage of food purchase decisions are made in the store.

2. A comparison between anticipated and actual food purchases for two random population samples showed there was little difference between anticipated and actual purchases for the population as a group. This indicates that total food expenditures and the allocation of expenditures among particular foods and food groups for the population as a whole are not substantially altered by the fact that many purchase decisions are made in the store.

Design of the Study

Comparison between actual and anticipated purchases for matched samples

If "impulse buying" or in-the-store decisions have a significant influence on the food purchases of a population group there should be a significant difference between actual and anticipated purchases for a pair of matched samples. The difference in purchases between one random sample reporting actual purchases (which would have been subject to "impulse" and in-the-store decisions) and another random sample from the same population reporting what they anticipate buying while sitting in their living room not influenced by what they see in the store should give an upper estimate of the aggregate influence of in-the-store choices. Such a survey was conducted in Lansing, Michigan during the spring and early summer of 1958.

A probability sample of 1200 families was selected by taking, after a random start, every *n*th residential address from the address section of the City Directory.[1] Half of the sample was assigned, in an alternating man-

[*] Journal paper No. 2591 from the Michigan Agricultural Experiment Station.

[1] Published by R. L. Polk and Co., Detroit, Mich. Addresses were listed in numerical order by streets in alphabetical order. After no less than three call-backs, one of which had to be in the evening, substitution of the next address was made for those which could not be contacted.

ner, a questionnaire which asked for a record of all food purchases for the past seven days. The other half of the sample was assigned questionnaires which asked, "Assume that for some reason you had to order all of your food for the next 7 days right now by telephone—what would you order?" In each case the respondent was given a form listing, by classes, approximately 650 different food items with space to indicate quantities, prices and expenditures for each. Space was provided for writing in items not itemized in the form.

Approximately the same number of each type of schedule (actual or anticipated) was taken each week over a three month period. Thus the anticipated and actual purchases are for very nearly the same time period. The data are weekly observations but representative of a three month period, not a single week.

Comparison between actual and anticipated purchases for same families

A comparison between actual and anticipated food purchases for a single sample of families was also made to provide a further estimate of the influence of in-the-store decisions. This was done by asking the families reporting anticipated purchases to keep a diary the following week reporting purchases actually made for the same time period they had reported their anticipated purchases. They were asked to return this record by mail. They were offered no reward for keeping the record and there was no follow-up reminder. A total of 199 useable reports (about ⅓) were returned.

These two records from each family provided data for two types of comparisons. It is possible to determine the differences between actual and anticipated purchases for each individual family with these differences becoming basic data. This provides data for estimating the number of purchases (total or for individual products) which were unanticipated or unplanned. This is the essential data used in such "impulse buying" surveys as have been done by the Du Pont Company.[2]

An alternative tabulation is to sum the anticipated purchases and the actual purchases and compare the sums for the population. In this case if 10 families anticipated buying a pound of white sugar and instead brought brown sugar and another 10 families did the opposite the analysis would indicate no difference between actual and anticipated purchases of white and brown sugar. These estimates are comparable to those obtained from the two matched random samples. It is from this type of analysis that the impact of these "unplanned" purchases on total sales can logically be implied. It cannot be implied from the individual family differences.

[2] *Today's Purchase In Super Markets,* Film Department, E. I. Du Pont de Nemours & Co.

Comparison of Anticipated and Actual Purchases

Matched samples

There was very little difference in the average per capita expenditures for all food or for each of 9 major food groups between the samples reporting anticipated and actual purchases, as shown in Table 1. There were only minor differences in the average number of purchases per family between the two samples. The average number of purchases was significantly different according to statistical test for only two product groups,

TABLE 1. COMPARISON OF AVERAGE EXPENDITURES AND AVERAGE NUMBER OF PURCHASES FROM REPORTS OF ACTUAL PURCHASES OF FOOD FOR PAST WEEK AND REPORTS OF ANTICIPATED PURCHASES FOR FOLLOWING WEEK FROM MATCHED SAMPLES[1]

Product Class	Average Expenditure Per Capita		Average Number of Purchases Per Family	
	Anticipated	Actual	Anticipated	Actual
Total Food at Home	$7.00	$7.18	31.3	29.7
Dairy Products[a]	1.13	1.10	3.3	3.2
Fats and Oils[a]	.36	.38	1.8	1.8
Fruits	.73	.73	4.3*	3.8
Vegetables	.71	.72	6.3	5.9
Meat, Poultry and Sea Food[b]	2.39	2.50	6.7*	6.2
Bakery and Cereal Products	.75	.78	5.5	5.5
Sugar, Sweets and Nuts	.22	.25	1.6	1.4
Beverages[c]	.49	.51	1.3	1.4
Cooking Aids	.18	.16	.4	.4

[1] Based upon 600 families reporting actual purchases and 593 reporting anticipated purchases.
[a] Butter is included in fats and oils.
[b] Includes eggs.
[c] Not including fluid milk or fruit juices.
* "Anticipated" was significantly different from "actual" at 5 percent level.

meats and fruits, and in each case the anticipated purchases exceeded the actual. (The differences, while statistically significant at the 5 percent level by *t*-test, were not large.)

A comparison was also made between the reports of the 600 families reporting actual purchases and the 593 families reporting anticipated purchases for each of 575 items which were reported purchased by one or more families.[3]

[3] Unfortunately the definition of a product or item is rather arbitrary and ambiguous—it could be provided precisely only by listing all of the items assigned a differentiating code. Items were *not* differentiated in respect to brand or size of package. In other words butter was treated as one item regardless of brand or type of package. In general items were differentiated in respect to method of preservation—fresh, canned and frozen peas would be three different items. The code was such that it identified at least 857 different food items.

TABLE 2. COMPARISON OF AVERAGE EXPENDITURES AND AVERAGE NUMBER OF PURCHASES FROM REPORTS OF ANTICIPATED PURCHASES OF FOOD AND REPORTS OF PURCHASES ACTUALLY MADE FOR SAME WEEK BY SAME FAMILIES[1]

Product Class	Average Expenditure Per Capita		Average Number of Purchases Per Family	
	Anticipated	Actual	Anticipated	Actual
Total Food at Home	$6.95	$6.94	31.2	33.7
Dairy Products[a]	1.22*	1.08	3.6	3.6
Fats and Oils[a]	.31	.31	1.6	1.5
Fruits	.68	.69	4.1	4.2
Vegetables	.68	.73	6.2	6.5
Meat, Poultry and Sea Food[b]	2.34	2.32	6.8	6.9
Bakery and Cereal Products	.76	.86	5.7*	6.8
Sugar, Sweets and Nuts	.23	.26	1.6*	1.9
Beverages[c]	.50	.45	1.2	1.4
Cooking Aids	.18	.19	.5*	.7

[1] Based on reports of 199 families.
[a] Butter is included in fats and oils.
[b] Includes eggs.
[c] Not including fluid milk or fruit juices.
* "Anticipated" was significantly different from "actual" at 5 percent level.

For the great majority of products there was no significant difference in the percent of families buying between the two samples. For only 16 items was the percent of families actually purchasing significantly greater (at the 5 percent level by *t*-test) than the percent anticipating purchases. For 31 items the percent of families anticipating purchase was significantly greater than those actually purchasing.

Same families

The comparison between the reports of actual purchases and anticipated purchases for the same group of families for total food and each of nine food groups is summarized in Table 2. The results were essentially the same as found in the comparison of the matched samples. Average per capita expenditures for food and for each of the food groups showed very little difference between these families' anticipated purchases and purchases actually made (although the difference for dairy products was significantly different at the 5 percent level[4]). A very close similarity also existed between the averages obtained from the matched samples and those obtained from the two reports from the same families. There was somewhat less correspondence among the four samples in respect to the average number of purchases, but again the differences were not great.

[4] One would expect one of these 20 averages to test significantly different at the 5 percent level simply on the basis of chance, so too much should not be made of this difference.

TABLE 3. COMPARISON OF ANTICIPATED AND ACTUAL EXPENDITURES OF INDIVIDUAL FAMILIES[1]

Product Class	Percent of Families with Actual Expenditures Differing from Anticipated by—		Percent of Families with Actual Expenditures Larger or Smaller than Anticipated by More than 10 Percent	
	Less than 10 Percent	More than 50 Percent	Larger	Smaller
Total Food at Home	19	20	39	42
Dairy Products[a]	22	32	31	48
Fats and Oils[a]	25	47	38	38
Fruits	12	51	46	43
Vegetables	15	43	47	38
Meat, Poultry and Sea Food[b]	16	34	42	42
Bakery and Cereal Products	12	35	53	35
Sugar, Sweets and Nuts	20	60	48	32
Beverages[c]	31	41	37	32
Cooking Aids	52	39	29	19

[1] Based upon two reports from each of 199 families.
[a] Butter is included in fats and oils.
[b] Includes eggs.
[c] Not including fluid milk or fruit juices.

This evidence indicates that "unplanned" or "impulse" purchases of food do not alter the average expenditures for food or the allocation of expenditures among these nine major food groups.

However, this does not mean that actual expenditures were the same as anticipated expenditures *for each individual family*. Quite the contrary was true, as is shown in Table 3. Actual expenditures for total food were within 10 percent of total anticipated expenditures for only 19 percent of the 199 families completing the two reports. Twenty percent of the families had actual food bills which differed from the anticipated expenditures by more than 50 percent. Actual expenditures differed from anticipated by more than 10 percent for more than two-thirds of the families for each product class except one. And actual expenditures differed from anticipated by more than 50 percent for more than one-third of the families for each product class.

The second part of Table 3 gives a clue to the reason for the apparent inconsistency of these data with those presented in Table 2 for the same families. About as many families actually spent more than they anticipated as spent less than anticipated. This was true of total food and more or less true for each of the nine food classes. *Thus the differences for individual families were compensating with the result that anticipated and actual expenditures were different for most individual families yet were not different for the population as a group.*

Data on the number of purchases were tabulated in the same manner as those for expenditures shown in Table 3. The pattern of results was very similar to that shown for expenditures.

A comparison of the percent of families actually buying with the percent anticipating buying for each item for the same families also provided results very similar to those for the matched samples. In both cases only about 7 percent of the items showed a significant difference (at the 5 percent level) between the percent of families anticipating the purchase and those reporting an actual purchase. Of the items which tested significantly different, the percent anticipating the purchase was greater for 12 items and the percent actually making the purchase was greater for 28 items. Only 12 items were significantly different for both the matched samples and the same-family comparisons.

This evidence indicates that "unplanned" or "impulse" purchases of individual food items, disregarding brand, alters the frequency of purchase of only a very small number of food items.

However, this does not mean that each individual family actually bought most of the items which they anticipated buying during the following week. An item-by-item comparison was made for each family between what they anticipated buying and what they reported actually buying. The average homemaker reported an actual purchase of 49 percent of the items which she anticipated buying. *Of the actual purchases made only 46 percent of the items were anticipated.*

Of those items purchased by 10 percent or more of the families, more than 70 percent of the actual purchases were anticipated for 15 items. These items, along with the percent of actual purchases which were anticipated, were: eggs, 92 percent; head lettuce, 90; white enriched bread, 89; butter, 86; cottage cheese, 81; frozen orange juice, 80; skim milk, 79; ground coffee, 77; soda crackers, 77; whole or cracked wheat bread, 76; oleomargarine, 74; pre-packaged ice cream, 74; wieners and franks, 72; homogenized milk, 72; and vegetable and meat soup, 71.

Of those items purchased by 10 percent or more of the families, less than 30 percent of the actual purchases were anticipated for 12 items. These were: plain cookies with frosting or marshmallow, none; frosted or sugared doughnuts, 4 percent; fruit filled cookies, 8; canned navy beans, 15; canned tomatoes, 18; brown sugar, 20; canned cucumber pickles, 24; plain or sugared cookies, 25; sausage, 27; salt, 29; plain boxed spaghetti or macaroni, 29; and canned pineapple, 29.

Conclusion

These data indicate that for this population neither total expenditures for food nor the distribution of consumer purchases among food groups

or among individual foods is significantly altered by in-the-store decisions. This is indicated by the evidence that (1) there was little difference in food purchases between two matched samples, one of which reported actual purchases and the other anticipated purchases, and (2) there was little difference in actual purchases and anticipated purchases for a sample of families reporting both.

The majority of food purchases are in-the-store choices and are different than would be made by individual consumers at the time of purchase if food were ordered from home without "contact" with the store. This is indicated by the evidence that less than half of the actual purchases made by individual families were anticipated. This is consistent with the findings of other studies, which have indicated that a large proportion of food purchase decisions are made in the store.

These two apparently contradictory conclusions are not inconsistent if the influence of factors affecting consumer choices in the store cancel out over time or between families. The data provide evidence that this happens.

The data for this study were collected over a period of about three months so they are data "over time," not for a particular one-week period. Many studies have indicated that "in-the-store stimuli" influence purchases for a particular week or for particular stores. Such findings are not inconsistent with the results of this report. In-store promotions may substantially increase sales during the period of promotion. Also, an individual store may gain sales by its display techniques. However, this study suggests that such findings may reflect gains at the expense of competing stores or of future sales rather than indicating a significant increase in consumer expenditures over time.

It is also likely that past experiences in grocery stores influenced what consumers anticipated purchasing. Thus it is possible that in-the-store stimuli may have some longer-run influence on purchases.

These data indicate that the observation that many purchase decisions are made in the store does not justify the conclusion that many food purchases are based upon "impulse," that the purchases are irrationally made, and that consumers are subject to substantial manipulation through control of stimuli in the store situation. By referring to in-the-store purchase decisions as "impulse purchases" the implication is made that the purchases are inconsistent with the established preference pattern of the shopper. For if the word "impulse" is used in any ordinary sense it implies spontaneous action not governed by reason.

However, the store may be the most rational place to make many food purchase decisions, since it is there that prices, quality, and availability of substitutes and complements may best be included in consideration. Pur-

chases decided upon in the store certainly need not be inconsistent with the long-run preference pattern of the family; the evidence of this study is that they are probably consistent.

This study did not deal with purchases of branded products. It may be that "impulse buying" and "in-the-store stimuli" are important in determining the allocation of expenditures among the different brands of a commodity. A study similar to the one of this report but distinguishing branded products should prove interesting.

CONCEPTUAL MODELS OF CAPITAL RATIONING AMONG FARMERS*

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CAPITAL rationing in agriculture has been alluded to and discussed by many writers. Schultz states as a presumption that "there exists for agriculture both external and internal capital rationing."[1] However, little has been done to measure or estimate the extent of these phenomena.

A study has been done to determine the extent of internal and external capital rationing among farmers in central Indiana. In this study external capital rationing means that additional credit is not available to the farmer at going rates of interest because of limitations imposed by lenders. Internal, or self-imposed, capital rationing means that additional credit is available, but the farmer elects not to use it.

A normative and a predictive model were developed for the analysis. This paper describes the models, which the research workers have found useful in orienting themselves to the problem and in designing their investigation of the problem. It then reports results of a preliminary study in which the models were employed.

The normative model (figure 1), which abstracts from the "real world," is based on the following simplifying assumptions:

1. Farmers have perfect knowledge.
2. There is no variability of income.
3. The short-run goal is profit maximization.
4. The long-run goal is to gain control of an optimum combination of resources by ownership (no rented factors).
5. Low-equity financing of farm businesses is not an alternative.

The first three assumptions are in the context of static production economics theory. The fourth assumption is self-explanatory. The fifth assumption excludes from the normative model such types of low-equity financing as provided by Farmers Home Administration, since relatively few of these loans are administered. Unlimited application of low-equity loans would preclude external capital rationing.

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** The author acknowledges helpful suggestions on an earlier draft by M. R. Janssen and J. H. Atkinson.

[1] T. W. Schultz, *The Economic Organization of Agriculture*, McGraw-Hill Book Co., Inc., New York, 1953, p. 306.

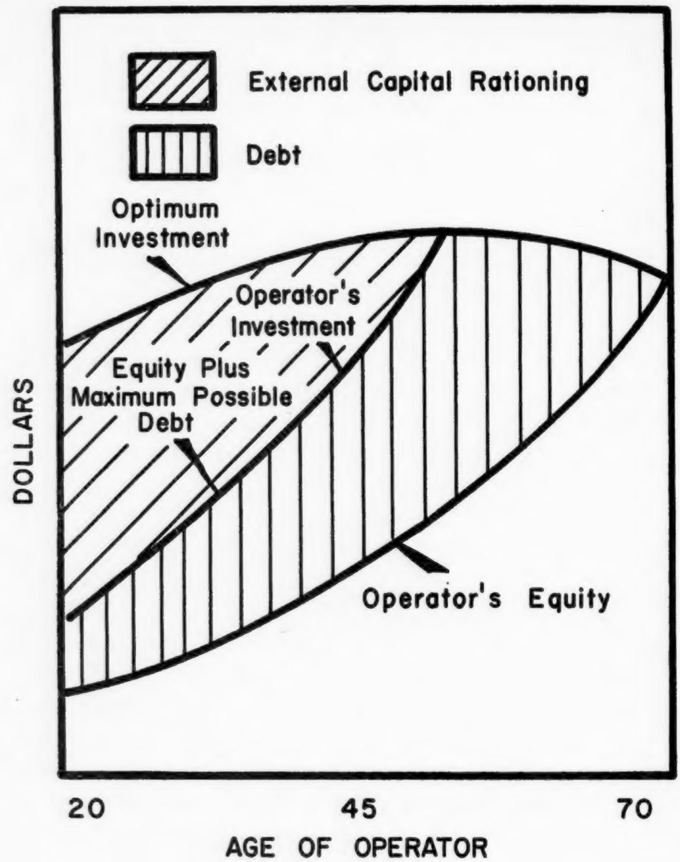

FIGURE 1. NORMATIVE MODEL.

In the normative model, equity is a function of the age of the operator (or the age of the business). No dollar amounts are placed on the vertical axis because the optimum will vary for farmers with different managerial abilities, for different geographic regions, and for different types of farming. Although the theory of capital accumulation is not highly developed, net capital accumulation (owner's equity) is shown as a curvilinear relationship. Net income in excess of living expenses is continuously reinvested. With living expenses relatively constant, successively larger net returns are concomitant with successively larger total investments, effecting an increasing rate of capital accumulation, at least through some range.

Debt is shown as a function of equity, as many lenders lend on a percentage-of-equity basis. In the normative situation, the farm operator

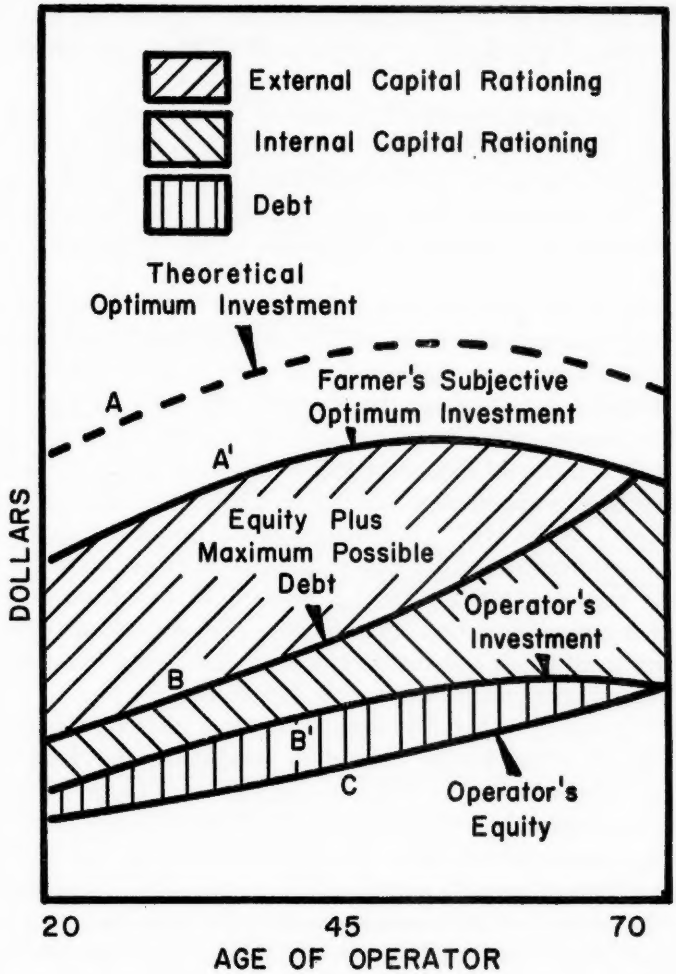

FIGURE 2. PREDICTIVE MODEL.

will increase his investment by using all the credit that is available to him until he has reached the optimum investment. Under the stated assumptions, the theoretical optimum investment will occur at the point at which

$$\frac{P_y \dfrac{\Delta Y}{\Delta X_1}}{P_{x_1}} = \frac{P_y \dfrac{\Delta Y}{\Delta X_2}}{P_{x_2}} = \cdots = \frac{P_y \dfrac{\Delta Y}{\Delta X_n}}{P_{x_n}} = 1$$

in which Y is the product, P_y is the price of the product, X_i are the factors, and P_{x_i} are the prices of the factors. The line depicting optimum invest-

ment rises because of the operator's increasing experience, and then declines because of the declining productivity of labor associated with advanced age.

Until the optimum investment is attained by ownership, either with or without debt, size of business may be increased to the optimum by renting additional resources, particularly land. Implicit in the normative model is the assumption that owned resources can be substituted for rented resources in infinitesimal quantities as the operator's investment increases.

In moving to the predictive model (figure 2), which is a hypothesis to be tested, the assumptions made in the normative model must be relaxed. The theoretical optimum, in both the normative and predictive models, represents the point at which the marginal efficiency of capital (MEC) equals the interest rate.[2] Farmers would be expected to invest less than this amount because of imperfect knowledge, variability of income and goals other than profit maximization, even though they have enough fully owned capital. If the MEC at the height of the line A equals the interest rate, say 6 percent, we would expect farmers to invest up to the line A′, where the expected MEC is, say, 8 percent, if they have fully owned funds. (It is conceivable that some farmers may overestimate their optimum investment—their subjective optimum investment may rise above the theoretical optimum for some period of time.)

Operator's equity is hypothesized to increase relatively slower in the real world situation. Under normative conditions, the farm operator would use all the credit available to him in an attempt to attain the optimum investment by ownership. The predictive model shows that, on the average, farmers use fewer borrowed funds than are available to them, even though they are employing less capital than they would with ample fully owned funds. If we assume that the MEC decreases as more and more capital is employed in a business, then it follows that the MEC at B′ (and B) is greater than the MEC at A′, which is greater than the interest rate. If empirical evidence from a random sample of farmers prompts us to accept the predictive model, we shall have reason to believe that capital rationing exists among farmers.

Testing the Predictive Model

Two types of data could be obtained to "test" the predictive model: data from individual farmers covering a period of several years or data

[2] As pointed out by a *Journal* reviewer, however, "the $MEC = i$ criterion of optimum investment is valid only in an abstract business sense. It assumes that principal payments are offset by equity gains (gains in net worth). But equity increases are not available for payments. Principal payments must be made from net cash income. The farmer has the problems of whether the farm will provide a sufficient net cash income and whether the household can stand the forced saving."

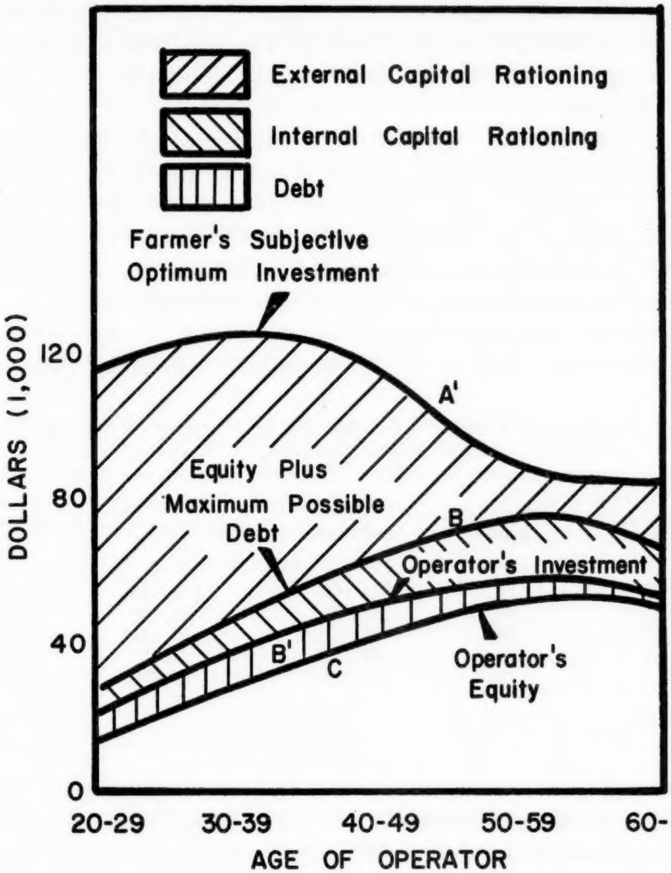

FIGURE 3. AGGREGATE EMPIRICAL "TEST" OF PREDICTIVE HYPOTHESIS.

from a random sample of farmers for one point in time. The difficulty of obtaining data over a period of years is obvious. The cross-sectional method was chosen because data were more readily obtainable.

A random sample of 146 full-time farmers in a relatively homogeneous (corn-hog) area in central Indiana were interviewed. From a farmer's answers to a series of questions, he was assigned numerical values for: subjective optimum investment;[3] equity plus an estimate of the largest total amount that he *could* borrow; operator's investment; net worth, or equity; and age. No attempt was made to define the theoretical optimum (A in figure 2); it was assumed that the theoretical optimum lies above the farmer's subjective optimum investment.

[3] Subjective optimum investment, as used here, means the amount that the farmer would invest in the total farm business if he had "plenty of money," assuming that he were to continue to farm. The amount was arrived at by a simple budget.

Parameters for the models were estimated by averaging the values for all farmers in each age group (figure 3). The results of this empirical test can be compared with the predictive model. There are both similarities and differences.

Equity appears to be a function of the age of the operator. The assumption of homogeneity of variance of net worths among the age-group populations was not tenable. Therefore, it was not feasible to use analysis of variance to test the null hypothesis that the mean net worths of the age-group populations were the same. However, the Welch test,[4] for which the assumption of equal variances is not required, was performed. The hypothesis of equal mean net worths among the age-group populations was rejected. Thus, it can be tentatively concluded that there is a relationship between the mean net worths of the age groups and the age groups. The procedure does not permit the making of statistical inferences about the nature or the degree of the relationship. However, confidence limits can be placed on the sample estimates of the means of the population (table 1).

TABLE 1. CONFIDENCE LIMITS FOR THE MEAN NET WORTHS OF FULL-TIME FARMERS IN VARIOUS AGE GROUPS, 146 FARMERS, CENTRAL INDIANA, 1958

Age group	Number of farmers	Mean net worth	95% Confidence limits	
			Lower	Upper
20–29	19	$14,071	$ 9,150	$18,992
30–39	28	28,780	21,173	36,387
40–49	45	41,960	26,421	57,499
50–59	33	52,694	38,643	66,745
60–	21	51,114	29,659	72,569
Total	146			

Apparently, there are considerations, or farmers believe there are considerations, besides equity that prescribe the amount of credit they can obtain. This is evidenced by the nearly parallel pattern of lines B and C in figure 3. There may have been some downward bias for farmers with larger net worths in their estimates of the largest amounts they could borrow. They may have judged their borrowing potential on amounts borrowed in the past without considering increased equities or inflated values. There was no statistically significant relationship between the age group and the mean amount of credit available for the age group.

Line A′, farmers' subjective optimum investment, crests at a younger age than was anticipated in the predictive model, although the differences

[4] B. L. Welch, "The Generalization of 'Student's' Problem When Several Different Population Variables are Involved," *Biometrika*, 34:28, 1947.

in the means are of no practical significance until reaching the 50 to 59 year age group. Based on the Welch test, it was concluded that there is a relationship between the age group and the mean subjective optimum investment of the age group. Again, no statistical inferences can be made about the nature or the degree of the relationship, but confidence limits can be placed on the sample estimates of the means (table 2).

Part of the reason for the hump in the early years may be related to the spirit of optimism prevalent among young farmers. Given this possibility, and if for some range their subjective optimum investment rises above the theoretical optimum, the area representing external capital rationing may be exaggerated. However, this particular study was concerned more with estimating the proportion of farmers who were on the

TABLE 2. CONFIDENCE LIMITS FOR THE MEAN SUBJECTIVE OPTIMUM INVESTMENT OF FULL-TIME FARMERS IN VARIOUS AGE GROUPS, 146 FARMERS, CENTRAL INDIANA, 1958

Age group	Number of farmers	Mean subjective optimum investment	95% Confidence limits	
			Lower	Upper
20–29	19	$115,700	$ 92,000	$139,400
30–39	28	125,900	95,900	155,900
40–49	45	116,900	100,700	133,100
50–59	33	88,700	76,800	100,600
60–	21	83,900	67,300	100,500
Total	146			

threshold of external capital rationing than with estimating the vastness of the area of external capital rationing, *per se*. That is, what proportion of farmers were using all the credit that their lenders would extend?

Other objectives were to determine what proportion of farmers had approached their subjective optimum investment by ownership, and what proportion were operating in the area of internal capital rationing. It was concluded from the empirical evidence that 14 percent of the farmers had control of enough assets that they would not have invested more in their businesses even if they had had more money (table 3). Three of these farmers had larger investments than they considered optimum, and either were in the process of liquidating or were considering liquidating part of their investment in the farm business and investing in some alternative.

Most of the remaining farmers would have increased the investment in their farm businesses if they had owned more funds. Exceptions were farmers classified under "self-recognized limitations of management," who were near retirement age or who were limited by abnormal health.

Ten percent of the sample were on the threshold of external capital rationing—they had obtained virtually all the credit that their lenders

would extend. Six of the 10 tenant farmers in this category had Farmers Home Administration farm operating loans; two were young men who were just starting to farm and had loans from 2 or more sources; and two were farmers within a year or two of retirement age, each having a net worth of less than $5,000.

Five part-owner farmers were on the threshold of external capital rationing. Three of these had recently purchased farms, two of them on land contract. Each of the other two had about a 75 percent equity in a relatively small business. Each had credit from two lenders and, although neither had asked for it, each thought that he could not obtain more credit.

TABLE 3. CLASSIFICATION OF FARMERS BY CAPITAL CHARACTERISTICS AND TENURE, CENTRAL INDIANA, 1958

Classification	Tenure[a] T	Tenure[a] PO	Tenure[a] O-O	Average age	Average investment	Proportion of sample
	Number				*Dollars*	*Percent*
Optimum amount of capital invested[b]	0	11	9	55	102,700	14
Capital rationing:						
Internal	52	37	6	40	37,534	65
External	10	5	0	42	22,200	10
Self-recognized limitations of management[c]	4	9	3	60	37,425	11
Total	66	62	18			100

[a] Tenants, part owners and owner operators.
[b] Given their goals and values.
[c] Age or health limitations.

Nearly two-thirds of the farmers in the sample were classified as operating in the area of internal capital rationing. There were various degrees of usage of credit among farmers in this category, the range being from those using none of the credit available to those who were approaching the point of external capital rationing.

Some of the farmers classified as operating in the area of internal capital rationing believed that they were operating nearly optimum businesses, but with a large proportion of rented resources. They expressed a desire to substitute owned for rented land "when financially able." For some, being financially able meant obtaining a large enough down payment that they could buy a farm on contract—for others it meant virtually payment of cash for a farm.

Evidence indicated that several farmers (11 percent of the sample) who were classified under internal capital rationing were faced also with external capital rationing. Even though they could have obtained some

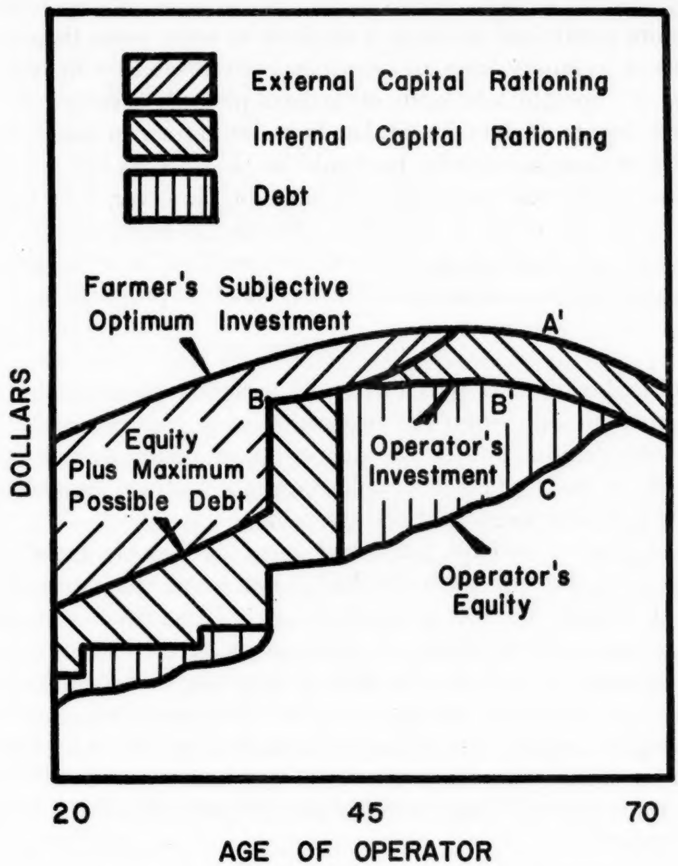

FIGURE 4. HYPOTHETICAL "DYNAMIC" MICRO MODEL.

additional credit, they could not have borrowed enough to do what they would have liked to have done because of the "lumpiness of inputs."

Although it is useful for certain kinds of analyses, it must be recognized that the above classification of farmers is static, as it is based on information taken at one point in time. However, the models can be adapted to "dynamic" analysis of the farm firm for those farmers who have data on net worth and debt for many points through time. From these data, lines representing equity and operator's investment can be constructed. However, it would be practically impossible to construct line A′ (subjective optimum investment) for any one firm from data obtained at an interview at one point in time because of changing goals, values, and knowledge.

A hypothetical example of a dynamic situation is given in figure 4. The

line representing equity is not as smooth as it is in the aggregate model because more profit (and savings) is realized in some years than in others. An increase in equity from an inheritance is reflected by the step at age 40. Line B′ (operator's investment) reflects periodic assumptions of debt for lumpy inputs. If data were taken from the farmer in this example for one point in time, say age 42, he would be classified as being in the area of internal capital rationing, and with no debt. However, if he were interviewed at the age of 45, he would be classified as being on the threshold of external capital rationing. While this is, perhaps, an extreme example, it illustrates the dynamic nature of farmers' financial progression.

Implications

The described models, plus a carefully designed questionnaire, provide a technique for estimating the proportion of a population that is confronted with external and/or internal capital rationing. Knowledge of the magnitude of each will have implications for further research—to help delineate problem areas—and for extension.

Sub-samples, or perhaps individual cases, of farmers faced with external capital rationing can be studied to determine the nature of restrictions that impede the flow of funds to agriculture. Such a study might help to develop criteria of the adequacy of the credit market.

Further study of farmers classified as operating under internal capital rationing will contribute to knowledge of their reasoning and rationale concerning the use of credit. What psychological attributes and other factors can be associated with farmers' use and non-use of credit? Answers to such questions will have implications for extension—both to farmers and to lenders.

AN APPRAISAL OF THE FARMER KNOWLEDGE SITUATIONS INVESTIGATED BY THE INTERSTATE MANAGERIAL SURVEY*

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THE philosophical problem "when does information become knowledge?" or "what constitutes knowledge?" is one that plagues those farm management research workers who delve into the study of decision making. To the extent that the study of the actions of managers is behavioral, i.e., to the extent that certain types of managerial action can be meaningfully related (in the sense of providing a basis for prediction) to certain observable or easily ascertainable characteristics of the manager such as age, education, tenure status, size and type of farm, we may have been tilting at windmills. If actions can be predicted, does it really matter whether they stem from "knowledge situations" or from situations involving "informed guesses" or "hunches"? However, when actions cannot be related to such easily ascertainable characteristics, the researcher may find it fruitful to investigate the manager's conception of the information relevant to his decisions. Study of managers' states of knowledge may lead to a better understanding of managerial behavior and thus contribute to educational programs concerned with managerial performance. Prospects of even limited success here appear to justify the efforts expended, and failures to explain how or why managers perform their tasks do not justify abandoning the attempt.

The questions in the Interstate Managerial Survey[1] relating to "Knowledge situations" arose from an attempt to extend a classification begun by Knight[2] in *Risk, Uncertainty and Profit,* and given further impetus by writers in statistics. Knight and his followers did not lay out a formal theory of knowledge but were more concerned with setting forth a theory which could be applied to explain the different types of situations which

* The investigation reported in this paper is in connection with the Kentucky Agricultural Experiment Station project, "A Study of the Decision Making Process in Farm Management," and is published with the approval of the Director. The writer would like to acknowledge the advice of Dr. A. N. Halter, project leader.

[1] For details regarding this phase of the Interstate Managerial Survey see: H. R. Jensen, et al., "Progress and Problems in Decision Making Studies," *J. Farm Econ.*, 34:1097-1125, Dec. 1955; G. L. Johnson, "Methodology for Studying Decision Making," *J. Farm Econ.*, 39:1215-29, Dec. 1957, especially pp. 1221-1222; and Interstate Managerial Project Committee, *Summary Data From the Interstate Managerial Survey,* Ky. Agr. Exp. Sta. Bul. 669, 1958.

[2] Frank H. Knight, *Risk, Uncertainty and Profit,* Houghton Mifflin Company, Boston, 1921.

they thought managers encounter. But when Knight says, "The writer is in fact a radical empiricist in logic, which is to say, as far as theoretical reasoning is concerned, an agnostic on all questions beyond the fairly immediate facts of experience,"[3] one might infer that he would expect farmers to be empiricists in classifying the situations which they encounter. That is, he might be expected to believe that farmers respond to situations on the basis of relevant empirical evidence.

To explore the agreement between farmers' decision making experiences and the hypothesized knowledge situations, all the farmers cooperating in the IMS were asked questions designed to determine whether they had encountered the following situations: (1) perfect knowledge, (2) risk action, both positive and negative, (3) learning, (4) inaction and (5) forced action. One-third (362) of these farmers were also asked, "What was the last major piece of machinery that you bought?" Since these farmers could be expected to remember their most recent major machinery purchases in considerable detail, their conception of these purchases was investigated. It was expected that the farmers would have been in one or more, and possibly all five, of the hypothesized knowledge situations before or at the time of the decision to make the purchase.

The machinery purchase was apparently viewed as a risk with insurance by 8.5 percent of the farmers and as a risk without insurance by 16.7 percent. Although it was evident that farmers had postponed their purchases to learn more about the problem, i.e., that they had experienced the learning situation, it was impossible to determine how the other 74.8 percent of the 362 farmers conceived their machinery purchase. The low proportion conceiving their machinery purchases in the terms hypothesized by IMS is taken to be damaging to the conceptual framework developed for and tested by this segment of the study.

The respondents' answers to the machinery purchase question were used as a basis for classifying the farmers into six clarity of understanding or "conception-level" groups.[4] These six conception-level groups, numbered in order from what was regarded as the clearest to the least clear conception of their most recent machinery purchase, were characterized as follows: (1) Group I expressed the problem as a difference between reality and some objective which they had, and also gave explanations of both reality and the objective. (2) This group was similar to Group I except that they gave no explanation of the objective. (3) This group was also similar to Group I, but offered no explanation of either reality or the

[3] Knight, *op. cit.*, see footnote, p. 201.

[4] For details of this classification see: John W. Hubbard, "A Study of the Decision Making of Farm Managers in Relation to Outputs and Specific Inputs" (Unpub. M.S. Thesis, Univ. of Kentucky, 1957).

objective. (4) Group IV included all who could not be included in one of the first three groups, but who provided an explanation of the situation in which they found themselves. (5) Group V provided a statement of the situation leading to the purchase, but gave no explanation of it. (6) Group VI merely expressed a need for the machine.

After classifying the 362 farmers into the six conception level groups, the farmers within each group were separated into the proportions that had viewed their purchases according to the knowledge situations hypothesized by IMS. The proportions of these six groups encountering the various hypothesized knowledge situations within the year were compared. Distinct differences in these proportions were not apparent among the six conception level groups. The distribution of the groups was significant by chi square test for only three of the knowledge situations. Two of these, the negative risk and the inaction situations, were significant at only the 20 percent level, while the third, the positive forced action situation, was significant at the 10 percent level.

TABLE 1. NUMBERS OF FARMERS ANSWERING MACHINERY PURCHASE QUESTIONS AND PROPORTIONS UNABLE TO GIVE VERIFIABLE EXAMPLES OF DIFFERENT KNOWLEDGE SITUATIONS

Knowledge Situation	Number Giving Answer Indicating Conception Level[a]	Percent Unable to Give Verifiable Example Within Year
Certainty	295	49.5
Positive risk	297	49.2
Negative risk	298	75.2
Learning	288	50.3
Inaction	298	81.9
Forced action	298	81.5

[a] The numbers are different since it was impossible to tell from their answers whether some of the farmers had been in the various knowledge situations. The maximum possible was 362 for each knowledge situation.

It would be expected that farmers with clearer understanding of particular machinery purchase problems would also be able to give more verifiable examples of encountering the different knowledge situations *if* they envisioned the situations confronting them in the hypothesized fashion. There was some evidence that this was the case, but it was not overpowering. The numbers of farmers who gave answers to the machinery purchase question which could be used as bases for the conception level classification, and the proportions of these unable to give verifiable examples of having encountered the different knowledge situations within the previous year are shown in Table 1.

Only slightly more than half of the farmers were able to give examples which could be verified in the cases of the two hypothesized situations

supported most heavily—the certainty and the positive risk situations. The learning situation was supported almost to the same extent, with 50.3 percent of the farmers unable to give verifiable examples from their farming experiences of the previous year. Negative risk apparently was not encountered by 75.2 percent of the farmers, while forced action and inaction were foreign to the experiences of 81.5 percent and 81.9 percent, respectively. The evidence that a majority of these farmers conceive of "knowledge situations" in the manner hypothesized is not overwhelming, to say the least. However, since the "knowledge situation" phase of IMS was intended to be in the nature of a second-round exploratory study, having been preceded by a small survey in Montgomery County, Kentucky,[5] no one connected with it should be too disappointed by the considerable number of the farmers interviewed who did not conceive of situations in the hypothesized manner.

We might ask the reasons for the apparent failure of this group of farmers to give answers substantiating the knowledge situation hypotheses. The most obvious answer which suggests itself is that farmers do not think of the situations which they encounter in this way.

Problem Conception and Theory of Knowledge

As intimated in the opening sentence of this article, one's definition of knowledge depends upon the theory of knowledge which he holds. An examination of the hypothesized knowledge situations in the light of the correspondence theory of knowledge may offer some logical bases for the lack of verification of the hypotheses tested by IMS.

Knowledge in the Light of the Correspondence Theory

Knowledge, according to the correspondence theory,[6] is a well-evidenced belief which corresponds completely with the appropriate objective situation. Truth, in the light of this theory, is absolute accuracy of correspondence between an objective situation, real or potential, and what is asserted about it. Any proposition missing complete accuracy by the slightest margin is a complete falsehood. In his discussion of this question, Williams states that any proposition entertained in any mind will be represented by four points, one located on each of four mental "scales" representing: (1) truth; (2) belief; (3) probability; (4) conviction. He represents these scales as shown in Figure 1.

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[5] Glenn L. Johnson, *Managerial Concepts for Agriculturalists,* Ky. Agr. Exp. Sta. Bul. 619, July 1954.

[6] For a more complete discussion of the correspondence theory of knowledge see: Gardner Williams, "Absolute Truth and the Shadow of Doubt," *Philosophy of Science,* Vol. XV, 1948, pp. 211-224.

One could compare these scales to four mental zippers along which one moves like the zipper closure tab. With the exception of the truth zipper, the zippers need not all be zipped up, i.e., at 100 percent, or all completely open, i.e., at zero, or all at any other given point at the same time. They are capable of independent operation. It will be shown, however, that the rationality assumption does decree certain relationships among the positions of the closure tabs on these three mental "zippers."

According to this theory truth is universal, i.e., if a proposition is true whenever one person asserts it, it is also true whenever any other person asserts it. Truth of propositions is recognized only in the mind. If no proposition is being entertained in any mind there is no truth, nor any false-

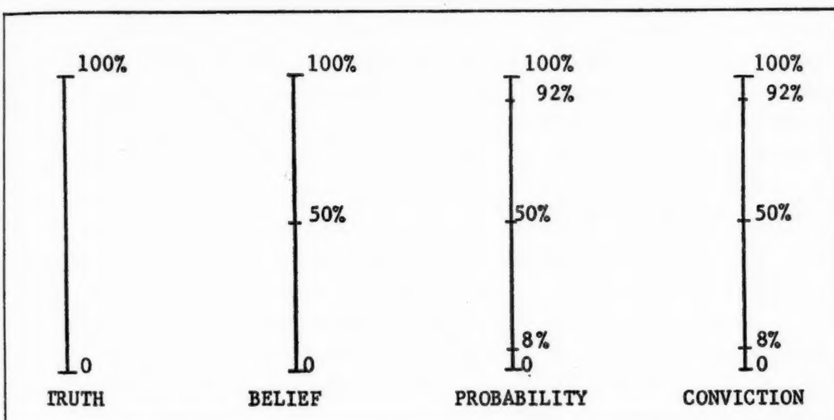

FIG. 1. SCALES RELEVANT FOR KNOWLEDGE DETERMINATION.

hood. The top of the truth scale means truth and the bottom means falsehood, or the truth of the contradictory proposition.

The probability scale measures the strength of the evidence which someone has to support or condemn a proposition. The correspondence theory holds that, when evidence is interpreted by reason, a proposition will be accepted as true when it is located between some minimum acceptance or "incredulity" point and the 100 percent end of the probability scale. Incredulity here means unwillingness or inability to believe. Thus, the incredulity points on the probability scale are those points beyond which, as one approaches an extremity of the scale, one cannot rationally refuse to believe or disbelieve a proposition, depending upon the end of the scale being approached.[7] However, as applied to management de-

[7] See G. Williams, *op. cit.*, p. 213, for an arbitrary selection of the 92 percent and the 8 percent probability levels as the levels at which propositions should rationally be accepted or rejected.

cisions, one might suppose that these points would shift up and down the scale depending upon the willingness of the manager to subject himself to error and upon the degree of importance he attaches to the proposition. The 100 percent probability point represents absolute rational certainty, but even this does not guarantee the truth of the proposition. This is so since the evidence, which is what the probability scale measures, may overwhelmingly support a false proposition or condemn a true one. Probability is not a subjective experience, but is rather the objective "chance of the truth" of some proposition.

The top of the belief scale means the acceptance of a proposition as

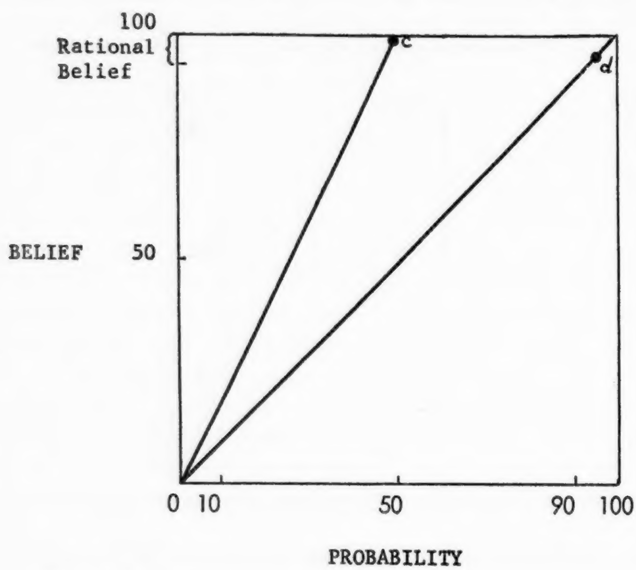

FIG. 2. RATIONAL AND IRRATIONAL BELIEF SITUATIONS.

true, while the bottom means its rejection as false. The 50 percent point represents suspended judgment. A person will stay at the 50 percent point on his belief scale, if he is rational, until his probability scale indicates that the evidence is sufficient to justify his either accepting or rejecting the proposition. When this amount of evidence has accumulated the person will snap (boinggg - - -) from suspended judgment to the range of belief or to the range of disbelief.

Knowledge aberrations

Two possible belief situations are shown in Figure 2. The vertical axis represents belief, the horizontal, probability. Point *c* represents 100 percent belief in a proposition supported by only 50 percent probability

based on the evidence. This is irrational, in terms of the probability.[8] Point *d* represents a rational belief in a proposition supported by a little more than 90 percent probability based on the evidence.

Conviction could also be placed coordinate to probability and the statements above would still apply. A person may be convinced of the truth of a proposition in spite of low probability, or may refuse to be convinced by high probability. A rational person's conviction scale will copy his probability scale, however. Two conviction situations paralleling the belief situations illustrated could be shown in Figure 2 by substituting conviction for belief, with 100 percent conviction of the truth of a proposition supported by only half of the evidence shown at point *c* and a rational conviction of the truth of a proposition supported by about 92 percent of the evidence shown at point *d*.

The conviction scale represents the strength of the confidence which a person feels in the credibility of a proposition. Then for any proposition which is supported by 80 percent of the evidence, his conviction of the truth of the proposition will also be 80 percent; at the same time, his conviction will be 20 percent opposed to the proposition, or in favor of its contradictory. When people set unduly high incredulity standards for themselves, their conviction scales will not copy their probability scales. Thus, a skeptical person may refuse to be convinced of the truth of a proposition which is supported by 99 percent of the evidence, while a too credulous person may accept one supported by less than 50 percent of the evidence. The same person may set different acceptance levels for himself at different points in time, or for different classes of propositions at the same point in time. A proposition located between the conviction standard and the nearest extremity of the scale is defined as a "popular certainty." This condition is to be distinguished from absolute rational certainty, which is 100 per cent probability. Conviction, like belief, is relative to an individual point of view; it is independent of truth.[9]

The Five Knowledge Situations Re-examined

To reiterate, knowledge is a belief which is well evidenced, and which is in complete correspondence with an objective situation. Thus, a belief which does not have this degree of correspondence, even though it might

[8] If a person substitutes some other scale for his probability scale, this substitute scale will have points on it which are similar in significance to the incredulity points on the probability scale. Belief or disbelief will occur for this person when the appropriate points on this substitute scale have been passed. Belief may be entirely independent of truth and is relative to the individual point of view. Scales of wish or faith, as well as a number of others, may be substituted for the probability scale by persons acting irrationally.

[9] That is, something may be false, even though either I believe it to be true, or I have a strong conviction that it is true.

be supported by 100 percent of the evidence, is not knowledge. Also, a belief which corresponds completely to an objective situation but is poorly evidenced is not knowledge, in terms of the above definition. Certainty can thus be said to have three meanings: (1) absolute certainty means the impossibility of error; (2) absolute rational certainty is 100 percent probability; (3) popular certainty, the ordinary meaning of the term, is an experience in which a proposition is above the conviction standard of incredulity. The first two are merely technical definitions.

To review, the five hypothesized knowledge situations investigated by IMS were: (1) perfect knowledge; (2) risk action, both positive and negative; (3) learning; (4) inaction; (5) forced action.

Since there are theoretical bases and some empirical evidence in contradiction to the above classification of the knowledge situations in which managers find themselves, it behooves us to propose a classification more in accord with the theory of knowledge which has been presented and hence to provide a more testable theory.

The perfect knowledge situation

We have no reason to believe that perfect human knowledge exists, and have indicated that absolute certainty and absolute rational certainty, as they have been defined in this presentation, are technical terms describing theoretical situations not encountered in real life.

The inaction situation

In the inaction situation, as defined for IMS, the manager is envisioned as doing nothing since he is thought to believe that his information concerning a proposition is inadequate for either a positive or a negative action. The manager is also thought to believe that the cost of acquiring more information exceeds its value to him. But, is this a necessary classification? A rational manager will only be in such a situation when his probability scale has not indicated that the evidence is sufficient to justify his either accepting or rejecting the proposition. He will suspend judgment until sufficient favorable or unfavorable evidence is accumulated for a decision to be made and acted upon. As to the cost of the evidence exceeding its value, this is a separate proposition to be considered on its own, on the basis of the evidence for and/or against *it*.

The forced action situation

A forced action, as conceived by IMS, is one forced upon the manager by some outside influence. Obviously, many influences are external to the person of the manager, but in order for such influences to condition a decision the manager must be consciously or unconsciously aware of

them. This being the case, does a rational manager act until the evidence indicates that he should act? The hypothesized outside influence could change the proposition, i.e., it could change the objective situation with which the manager is dealing and thus the proposition would need to be reworded. If this is not the case, then the outside influence introduces additional evidence, or is additional evidence, having to do with the original proposition. If this added evidence is sufficient to bring the total evidence to a point on the probability scale where conviction of the truth of the proposition is warranted, the manager will believe it, and will govern his action accordingly. If the outside influence (additional evidence) is sufficient to bring the total evidence to a point which warrants a rational belief that the proposition is false, then a negative action will result. If the outside influence is insufficient to push the total evidence either to the point on the probability scale which indicates that the proposition should be accepted, or to the point toward the zero extremity which indicates that the proposition should be rejected, the manager still will not act in spite of the outside influence. He will continue to suspend judgment, pending receipt of more evidence, i.e., he will perform the action of "not acting."

The learning situation

Managers continually face situations in which they need to learn. The managers whom we would assign to the learning category are those who are suspending judgment about some proposition. They are at the 50 percent point on their belief scales accumulating additional evidence bearing on their propositions. Given the important rationality assumption, a manager will be at the 50 percent point on his belief scale for any and all propositions being entertained until the evidence, measured on his probability scale, indicates that the proposition should rationally be accepted or rejected. His conviction of the truth of the proposition, meanwhile, will move up and down the conviction scale reflecting the mounting supply of evidence for and against the truth of the proposition. The evidence may, for example, be 75 percent in favor of a given proposition and, if it is, his conviction of the truth of the proposition will also be 75 percent. Nevertheless, belief will be suspended (at 50 percent) until a point on the probability scale has been passed which indicates that the proposition is true or false. The manager can no longer refuse to believe, or to disbelieve, the proposition. In an instant his belief will snap from the 50 percent point to the range of popular certainty of the truth of the proposition or to the range of popular certainty of the falsity of the proposition. Once the available evidence reaches either incredulity point on his probability scale, the manager will take an appropriate positive or nega-

tive action. The period of time during which a proposition is under consideration, while learning or evidence gathering is occurring, could be termed a situation of "suspended action," but since "learning" has come to be generally accepted, no useful purpose would be served by changing the designation. We must remember that it applies to the "evidence gathering" stage preceding rational action.

The risk action situation

Finally, if we assume that managers are rational, we can embrace the "risk action" situation as defined for IMS provided that we apply the risk concept to the theoretical chance that the manager may have believed a well-evidenced proposition which proved to be false. In such cases, the belief which the manager had was not knowledge, though he thought it was when he acted. A useful designation for this "risk" situation could be either "popular certainty" or "subjective certainty." This is the situation in which managers act as if they were certain of the outcomes of their actions.

Conclusion

This leaves us with two meaningful knowledge classifications: (1) the learning or "evidence gathering" situation; (2) the subjective certainty or popular certainty situation.

In terms of the IMS classification the following was done: (1) The certainty situation was redefined retaining only the "popular certainty" or subjective certainty situation and this was shown to include the risk situation (positive and negative). Any action taken will originate from a position of popular or subjective certainty. (2) The learning situation was retained, but was shown to include the inaction situation. (3) The forced action classification was abandoned since outside influences merely introduce additional evidence which is considered by the manager in determining his course of action.

The above appears to be justified in light of the evidence indicating that the knowledge situations investigated by IMS were overelaborate. I am suggesting that the classification of situations proposed above is preferable to the classification investigated by IMS since it is shorter and simpler, but nevertheless includes the essential features of the latter.

NOTES

A COMMENT ON THE HARRIS ESTIMATION OF THE TREASURY COST OF EISENHOWER'S WHEAT PROGRAM

W. E. Hamilton
American Farm Bureau Federation

THE November, 1959 *Journal* note entitled "Eisenhower's Wheat Program: An Estimation of the Treasury Cost for 1959" by Curtis C. Harris, Jr.,[1] is misleading insofar as it purports to be an analysis of what the President actually recommended.

Referring to President Eisenhower's 1959 recommendations on wheat, Harris said:

> The means of getting a "workable wheat program" he went on to say, is "to reduce the incentive for excess wheat production." His solution to the surplus problem was presented in his January message. He proposed the elimination of all acreage and marketing controls, and guaranteed prices at 90 per cent of the average market price for the three calendar years preceding the crop year in question.

Official records make it clear that the Administration did not contemplate such a level of price support in combination with the elimination of controls without transitional provisions designed to reduce the cost of the wheat program.

The President's proposals were first outlined in a special message to Congress in January, 1959. The pertinent section of this message, which covered other crops in addition to wheat, reads as follows:

> I recommend that prices for those commodities subject to mandatory supports be related to a percentage of the average market price during the immediately preceding years. The appropriate percentage of the average market price should be discretionary with the Secretary of Agriculture *at a level not less than 75 and not more than 90 per cent of such average* in accordance with the general guidelines set forth in the law. Growers of corn, our most valuable crop, have already chosen, by referendum vote, program changes which include supports based on such an average of market prices.
>
> If, despite the onrush of science in agriculture, resulting in dramatic increases in yields per acre, the Congress still prefers to relate price supports to existing standards, the Secretary should be given discretion to establish the level in accordance with the guidelines now fixed by law for all commodities except those for which supports presently are mandatory.
>
> Either of these changes would be constructive. The effect of either would be to reconcile the farm program with the facts of modern agriculture, to reduce the incentive for unrealistic production, *to move in the direction of easing*

[1] *J. Farm Econ.*, 41:815.

production controls, to permit the growth of commercial markets and to cut the cost of Federal programs.[2] (Emphasis added.)

Further details of the President's proposals for wheat were spelled out by Secretary Benson in appearances before Congressional Committees. In addition, specific suggestions for changes in existing legislation were submitted to the Senate Committee on Agriculture and Forestry by letter and subsequently made public by the Committee.[3]

In keeping with the President's original message, this letter transmitted the language needed to effectuate a series of alternative proposals. These alternatives were grouped into two separate approaches, labeled "Relaxation of Controls" and "Control Route." Alternative (A) under the "Relaxation of Controls" approach—the Administration's first choice—called for discretionary authority (1) to increase, rather than abolish, allotments in the 3-year period 1960-62, and (2) to establish price supports for the 1960-62 period at ". . . not less than 75 percent or more than 90 percent of the average price received by farmers during the 3 preceding marketing years."

Alternative (A) under the "Control Route" approach provided for price supports at 90 per cent of the three-year market average price, but *in combination with "basic changes in the present program" which would have reduced the national acreage allotment, eliminated marketing quota exemptions, and otherwise tightened existing controls.*

The extent to which the Administration would have used the discretionary authority requested under its preferred approach is, of course, debatable. Nevertheless, the concern frequently expressed by President Eisenhower and Secretary Benson with respect to the cost of the wheat program, and their known desire to relax controls, strongly suggest that the full authority to reduce wheat supports to 75 per cent of the 3-year average would have been used, at least for the first year of the new program. The difference between 75 and 90 per cent of the 3-year average is significant. This is so not only because of possible effects on production, CCC acquisition costs and export subsidy rates; but also because it is to be expected that the demand for wheat would become considerably more elastic if support prices were to be lowered sufficiently to permit wheat to compete effectively in the domestic feed market.

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[2] Support Prices for Agricultural Commodities—Message from the President (H. Doc. No. 59), *Congressional Record,* January 29, 1959, pages 1189-1190.

[3] Wheat Price Supports and Acreage Allotments, letter from the Department of Agriculture, transmitting drafts of the legislative changes, together with explanations thereof, that would be necessary to put into effect alternative proposals for wheat in accordance with the President's Agriculture Message and the testimony of the Secretary, February 16 and 17, 1959, to the Committee on Agriculture and Forestry, United States Senate, March 12, 1959, printed for the use of the Committee on Agriculture and Forestry.

The Harris note could be dismissed as an exercise in methodology, except for the author's statement that:

The purpose of this paper is to estimate the Treasury cost of Eisenhower's wheat program for 1959 and compare it with an estimate of the Treasury cost that would be incurred if the present wheat program were to remain in effect.

As Harris has indicated, a program that would abolish acreage allotments and marketing quotas without materially reducing price supports for wheat would be expensive for the Treasury. The results of his analysis would have been considerably different if he had assumed that the President's program may have contemplated reducing price supports sufficiently to permit wheat to compete effectively in the domestic feed market within 1 to 3 years.

THE EISENHOWER WHEAT PROGRAM—A COMMENT

TED RICE
*Continental Grain Company**

THIS writer feels that the Note in this *Journal,* "Eisenhower's Wheat Program: An Estimation of the Treasury Cost for 1959,"[1] needs a comment for two reasons:

1. The methodology of estimating acreage to be planted under assumed conditions lacks precision.
2. The analysis makes important omissions in calculating costs to the Treasury.

Methodology

The author of the Note states, "During the six years [1947, 1948, 1949, 1951, 1952, 1953] in which there were no acreage controls, the average annual acreage seeded [to wheat] was 79 million, and the average annual support price was $2.06 per bushel. The same production response is expected to exist for 1959, i.e., at $2.06 per bushel it is assumed that farmers would seed 79 million acres to wheat."[2] The author then applies a mathematical formula based on a 1909-1932 time series to show the acreage if the price support were lowered to $1.68. Besides the use of an antiquated time series, which the author recognizes as undesirable, there are at least 4 additional objections to using it.

a. The assumption is that changes in wheat acreage are entirely a func-

* The views are those of the Author and not necessarily those of Continental Grain Company.

[1] Harris, Curtis C., *J. Farm Econ.,* 41:815, Nov. 1959.

[2] Ibid., p. 816.

tion of change in price. It entirely fails to take into account the comparative advantage wheat has relative to other crops or even no crop. Schumaier has conclusively supported his thesis that "wheat acreage and production decline in Illinois when prices are unfavorable and increase when prices are favorable *compared with prices of competing crops.*"[3] (Italics mine.)

b. The assumption that production response in 1959 would be the same to a $2.06 price as in the 6 recent years of no acreage restrictions ignores the fact that from that period to 1959 the price support of corn, for example, declined 23 percent. Price supports for other crops also declined similar amounts.

c. U. S. wheat is referred to as a single commodity. Actually it is at least six commodities: Hard winter wheat, soft red winter wheat, hard spring wheat, eastern white wheat, western white wheat, and durum. Each class of wheat will have a different supply response to price because the areas which produce them have different alternative uses for land suitable for wheat. In North Dakota the alternatives may be between spring wheat and flax, which has a low yield per acre, or another small grain, which is usually inferior in price. In Illinois, the alternatives may be high-value-per-acre crops like soybeans and corn. Schumaier[4] demonstrated that in Illinois, wheat production adjustments relative to prices are greater in areas where there are more good alternatives to wheat than in areas where alternatives are more restricted.

d. No mention is made of the fact that a large amount of wheat is now produced on acreage which is in excess of acreage allotments because the law allows any farmer to plant up to 15 acres of wheat. In 1958, fifty-four percent of the farms seeding wheat in the U. S. exceeded their acreage allotments. These non-complying farmers overplanted by more than 6 million acres. This represented 11 percent of total U. S. wheat acreage. Logically, the only assumption one could make is that these farmers would reduce wheat acreage given no wheat acreage controls and lower prices.

Table 1 illustrates two points which are pertinent to methodology of estimating acreage planted to wheat and in estimating cost to the Treasury. First, note that total acreage planted to the important grain and seed crops (including soil bank) has not changed a great deal in the past decade in the three selected wheat producing states. As wheat allotments have been cut, acreage has merely been shifted to other crops. Second, this shift has been to the next best alternative crop. This alternative has varied among states. The major shifts have been in North Dakota to flax and barley, in Kansas to sorghum, and in Illinois to soybeans.

[3] Schumaier, C. P., *Relation of Wheat Acreage and Production to Wheat, Corn, Oat, and Soybean Prices in Illinois,* Ill. Agr. Exp. Sta. Bul. 648, Dec. 1959, p. 3.
[4] Ibid., p. 3.

TABLE 1. PLANTED ACREAGE OF MAJOR GRAIN AND SEED CROPS (MILLION ACRES)[1]

Year	Wheat	Corn	Soybeans	Oats	Barley	Rye	Sorghum	Flax	Soil Bank	Total
					North Dakota					
1949	11.1	1.2	*	1.9	1.9	.3	*	2.0	—	18.4
50	9.1	1.3	*	2.2	2.2	.3	*	2.0	—	17.2
51	10.7	1.2	*	2.1	2.4	.2	*	2.0	—	18.7
52	10.7	1.1	*	1.9	2.0	.2	*	1.6	—	17.5
53	10.3	1.2	*	1.9	1.9	.2	*	2.6	—	18.4
54	8.2	1.3	.1	2.3	3.2	.3	*	3.5	—	18.9
55	7.4	1.4	.1	2.1	3.8	.6	*	3.3	—	18.6
56	7.6	1.3	.2	1.8	3.3	.4	*	3.7	1.0	19.3[2]
57	6.5	1.4	.2	2.0	3.7	.3	*	3.8	1.8	19.7
58	6.5	1.4	.3	2.1	4.0	.4	*	2.7	1.5	18.8
59	6.9	1.4	.2	1.9	4.1	.3	*	2.3	1.8	19.0
					Kansas					
1949	16.2	2.5	.3	1.0	.3	.1	2.4	*	—	22.8
50	13.8	2.6	.4	1.5	.6	.1	3.2	*	—	22.3
51	14.8	2.8	.5	1.2	.3	.1	4.1	*	—	23.8
52	15.1	2.8	.7	1.0	.1	.1	2.6	*	—	22.4
53	14.3	2.5	.6	1.2	.2	.1	3.9	*	—	22.7
54	11.7	2.3	.4	1.2	.6	.2	5.9	*	—	21.8
55	10.8	1.8	.4	1.4	.9	.3	6.5	*	—	22.1
56	10.9	1.8	.4	1.4	.8	.3	5.2	*	1.1	21.8[2]
57	7.2	1.6	.2	1.4	.8	.4	8.2	*	4.7	24.5
58	10.9	1.8	.4	.7	.8	.4	5.0	*	1.4	21.3
59	10.9	2.0	.4	.8	1.0	.3	5.2	*	1.1	21.7
					Illinois					
1949	2.0	9.3	3.5	3.9	*	.1	*	*	—	18.8
50	1.6	8.4	4.1	3.8	*	.1	*	*	—	18.0
51	1.8	8.9	3.8	3.4	*	.1	*	*	—	18.1
52	1.9	9.0	3.8	3.4	*	.1	*	*	—	18.2
53	2.1	9.4	4.0	3.2	*	.1	*	*	—	18.8
54	1.6	9.4	4.3	3.4	.1	.2	*	*	—	18.9
55	1.6	9.4	4.3	3.4	.2	.3	*	*	—	18.9
56	1.6	8.7	4.7	3.2	.1	.2	*	*	.5	19.6[2]
57	1.8	8.4	5.0	3.0	.2	.2	*	*	.4	19.0
58	1.8	8.8	5.1	2.7	.1	.2	*	*	.7	19.4
59	1.8	10.3	4.9	2.4	.1	.2	*	*	.3	20.0

* Less than 0.05 million acres.
[1] Totals may not equal total of columns because of rounding.
[2] Considerable acreage of wheat and other cropland was plowed up in 1956 to qualify for the Soil Bank. To this extent, total acreage is overstated.

Treasury Costs

In the matter of computing costs to the Treasury, the author made several errors and omissions.

a. He assumes that if there are no acreage restrictions and the price support were cut 13 cents, that the price of wheat would be cut 13 cents. Table 2 indicates that in the past 5 years the average price received by farmers for wheat has not equaled the support price. Furthermore, the larger the crop (e.g. 1958), the larger the discount under the loan.

TABLE 2. U. S. NATIONAL AVERAGE WHEAT SUPPORT LEVEL AND AVERAGE PRICE RECEIVED BY FARMERS

Crop Year	Support Price	Price Received
1954–55	$2.24	$2.12
1955–56	2.08	1.99
1956–57	2.00	1.97
1957–58	2.00	1.93
1958–59	1.82	1.75

b. No credit is given for the saving in wheat export subsidies. Currently the CCC pays a subsidy to offset the difference between our domestic free market price and the world price. On February 26, 1960 this subsidy at Texas ports was 66 cents per bushel, or 28¼ percent of the domestic f.o.b. value at Galveston, Texas. Given no acreage restrictions and a drop in price supports, the subsidy per bushel would drop by the amount of drop in price support plus the additional amount free market prices would sell under the supports in the absence of acreage restrictions.

c. The author assumes that wheat yields per acre would not decrease given an end to acreage restrictions. The areas which would increase wheat acreage most under a program of no restrictions would be the areas which have few alternative crops except small grains of lower value per bushel. With the exception of the Pacific Northwest, this would generally be areas with wheat yields below the national average.

d. He fails to consider that increases in wheat acreage would mean reductions in acreage and production of other crops. This means less corn, oats, barley, sorghum, rye and soybeans would move into CCC control. Except for interest, it costs just as much to CCC to store a bushel of oats, barley, corn, or sorghum as a bushel of wheat. It should be noted that on a pounds-per-acre basis, Illinois produces more barley than wheat; and Kansas produces more sorghum than wheat.

In this writer's opinion, much better estimates of acreage seeded to wheat, given a reduction in wheat price supports to \$1.68, could be made by using a budgeting technique than by using an elasticity-of-supply response based on 1909-32 data. By considering alternative crops on a state-by-state or regional basis, one could make very acceptable estimates of wheat acreage seeded. It appears probable that given a \$1.68 price support and no acreage controls wheat acreage in North Dakota and Kansas might increase 30 to 35 percent. In Illinois, if the corn price support were \$1.12 per bushel and soybean price support \$1.91 per bushel, wheat acreage might be cut from that actually seeded in 1959. This writer is not challenging the thesis that wheat acreage would have been much larger than it actually was in 1959 had there been no acreage restrictions. In fact, the 72-million acreage estimate is probably conservative.

In considering costs in 1963, given no acreage restrictions and supports at 90 percent of the previous 3-year average, the author made the same four omissions noted for the 1959 crop. It appears probable that by 1963 the support price would not be \$1.35 per bushel but considerably less. Assuming the free market price would average 10 cents per bushel below the support price, given no acreage restrictions, the price support for 1963 would be only \$1.25 per bushel. At this level it is doubtful if the CCC

would have to pay any export subsidy on wheat to meet world prices.

It would seem to this writer that the assumption that CCC can recoup only 30 cents on each dollar invested in inventory is not valid as a long-run assumption or for 1963 if the price support for wheat were allowed to adjust downward. At some point the wheat price support level would fall below either the true world price level or the price at which it was competitive with corn for livestock feed. At such time the CCC could expect to liquidate its inventory at better than 30 cents on the dollar, particularly if the U. S. wheat support were below $1.25 per bushel.

Summary

This writer agrees with the author that "it seems that most agricultural economists would agree that the present program for wheat is too costly."[5] By the author's calculation, the present program under his assumed conditions for 1959, would cost 50 cents for each bushel of wheat produced in the U. S.

It does appear to this writer that the omission of the savings to the CCC on the wheat export subsidy and the savings resulting in smaller take-over (and possibly inventory reduction) of sorghum, oats, barley, corn, flax, and rye due to a shift of 14 million acres of other crops to wheat, makes the cost calculations under the Eisenhower Program unrealistic.[6] There is serious doubt that the present program would cost less than the Eisenhower Program in 1963.

[5] Harris, op. cit., p. 820.

[6] It appears that despite a record corn production in 1959, attributable in part to the ending of acreage restrictions, CCC will have a smaller addition to their inventories of items other than wheat than from the 1958 crops.

ON THE HARRIS ESTIMATION OF THE TREASURY COST OF EISENHOWER'S WHEAT PROGRAM: A REPLY

CURTIS C. HARRIS, JR.
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THE two preceding comments are different enough to require separate replies; therefore, this response is in two parts, the first directed to Mr. Hamilton's comment, the second to Mr. Rice's.

Reply to Mr. Hamilton

The program as considered in my note is clearly one alternative under the broad powers requested by the President. It was the alternative reported in the newspapers at the time my note was written, and thus was

considered as the intended alternative. I recognize that I failed to footnote the source of the information in the first three paragraphs. It was the newspapers on June 2, 1959, *e.g.*, the *New York Times*.

Mr. Hamilton contends that the difference between 75 and 90 per cent of the 3-year average is significant ". . . not only because of possible effects on production, CCC acquisition costs and export subsidy rates; but also because it is to be expected that the demand for wheat would become *considerably more elastic* if support prices were to be lowered sufficiently to permit wheat to *compete effectively in the domestic feed market*." (Emphases added.) It is true that the figures would have been different with the lower support price, but would the conclusion be any different? My conclusion was: "The results of this study indicate that neither surpluses nor Treasury costs would be reduced with his program."

In a letter from the Department of Agriculture to the Senate Committee on Agriculture and Forestry (see footnote 2 in Mr. Hamilton's comment), authority was requested to increase the national acreage allotment for wheat up to 50 per cent of the levels determined by existing formulas. My estimated seeded acreage response was only 24 per cent higher than the seeded acreage in 1959, with the support price at 90 per cent of the previous 3-year average. With the support price at 75 per cent of the previous 3-year average, the seeded acreage response would be only 14 per cent higher than the 1959 acreage.

Therefore, the assumption that there would be no acreage allotments would be a valid assumption unless the government intended to increase the allotments by only a small percentage.[1]

Based on the same data, equations, and procedure given in my previous note and the support price at 75 per cent of the market price of the last three years ($1.40 per bushel) with no acreage controls, the surplus would be about 400 million bushels and the net Treasury cost would be about 580 million dollars. These figures compare with the 570 million bushels and 1,000 million dollars estimated previously, with the support price at $1.68.

Some may question the demand response, as Mr. Hamilton seems to do, at this low support price. They would argue that the elasticity would be much greater at low prices since wheat would be used more extensively as a feed. This argument when applied to my estimates *using 1959 data* can be discounted for two reasons:

[1] Martin Sorkin, Assistant to the Secretary of Agriculture, in a letter to me dated December 9, 1959, stated: "In view of the objectives of increasing consumption primarily as feed and to reduce costs, your analysis should have assumed a level of price support based on 75 percent of the previous 3-year average for 3 years and then a shift to 90 percent." He made no mention of acreage allotments or production controls of any kind.

(1) The elasticity used, $-.41$, is a high estimate. Other estimates run as low as $-.04$.[2] Furthermore, it seems unlikely that wheat elasticity would run higher than the elasticity for feed concentrates, provided that the prices of wheat and other feeds would move together once the wheat became competitive as a feed. Estimates of feed elasticities run from $-.42$ to $-.55$.[3]

(2) The use of wheat as feed depends to a large extent on the difference between the price of wheat and the prices of other feeds.[4] Therefore, given the government corn program in 1959, the large corn surpluses, the low corn prices in 1959 (95.9 cents in December[5]), and the prospect of low corn prices in the future, it seems unlikely that wheat would "compete effectively in the domestic feed market."

It seems that my previous conclusion holds true: that the objectives of lowering the surpluses and the Treasury cost of wheat would not be achieved.

Reply to Mr. Rice

Mr. Rice listed my "omissions"—some of which I had myself mentioned in the note. He asserts that they make ". . . the cost calculations under the Eisenhower Program unrealistic." His implication is that my estimate was too high. Surprisingly, he says earlier that ". . . the 72 million acreage estimate is probably conservative."

Mr. Rice claims that acreage response could have been estimated more authoritatively "by considering alternative crops on a state-by-state or regional basis. . . ." Perhaps he is right. But before such a major task should be undertaken it would be wise to answer the following questions:

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[2] Examples of estimates of demand price elasticities for wheat are as follows:

–.04 Meinken, Kenneth W., *The Demand and Price Structure for Wheat,* Tech. Bul. No. 1136, U. S. Dept. of Agr. This estimate relates wheat used for food with Kansas City prices.

–.07 Fox, Karl A., *The Analysis of Demand for Farm Products,* Tech. Bul. No. 1081, U. S. Dept. of Agr. This estimate relates per capita flour consumption with farm prices.

–.08 Schultz, Henry, *The Theory and Measurement of Demand* (Chicago: University of Chicago Press, 1938). This estimate relates per capita utilization of wheat for all domestic uses with a deflated average price. When seed was excluded as a use and a longer time period studied, the estimate was —.2.

[3] This range of estimates was made by Richard J. Foote, *Statistical Analyses Relating to the Feed-Livestock Economy,* Tech. Bul. No. 1070, U. S. Dept. of Agr. He had three estimates (—.42, —.49, and —.55), depending on the years included and how changes in the variables were computed. He related the price of corn with the supply of feed concentrates. Fox, *op. cit.,* related the price of corn with the number of grain-consuming animal units on farms. His estimate was —.44. Schultz, *op. cit.,* got an estimate of —.48 by relating the deflated price of corn with per capita consumption of corn.

[4] See Meinken, *op. cit.,* and Fox, *op. cit.*

[5] Price received by farmers. *The Feed Situation,* Feb. 1960, Agr. Marketing Serv., U. S. Dept. of Agr.

(1) Would we have sufficient reason to believe that the estimate under the more complicated method would be more accurate? and if this is answered affirmatively,
(2) Would the degree of accuracy be improved sufficiently to justify the increased time, effort, and money spent, for the single purpose of approximating Treasury cost under a proposed program to see if it would cost more or less than the present program?

After presenting evidence that the price of corn has fallen significantly in recent years (which indicates that the profitability of corn compares less favorably with that of wheat in 1959 than in previous years), and that the increase in acreage of crops other than wheat was a result of lower wheat allotments and not of relative profitability, he had no choice but to think that my acreage response estimate was too low. I agree that it was conservative.

Therefore, his conclusion that Treasury costs would be lower must rest on something else. This "something else" is the four assumptions listed under the section headed "Treasury Costs." Let's examine them more thoroughly.

(a) *Average price received by farmers for wheat would not equal the support price.* To assume that this would continue is to assume that the loopholes and weak administrating in the present program would continue under Eisenhower's program. That is not necessarily the case. The government *could* make the market price equal to the support price.

(b) *Savings will occur in wheat export subsidies.* If anything, my estimates of Treasury cost should be increased by the amount of the *cash* subsidies.

The payment-in-kind subsidy, which is paid from CCC wheat stocks, has already been accounted for in my estimation procedure. For years before 1959, gross Treasury cost was estimated by adding the change in CCC inventories to the cost of dispositions. (Each is valued to include all costs connected with storage and handling.) Storage costs (all costs other than initial acquisition cost) were estimated by subtracting the initial acquisition cost (support price times quantity taken under support) from the gross Treasury cost. Similarly, when estimates were made for 1959 the subsidy was included since costs other than the initial acquisition costs were based on their historical relationship with the initial acquisition cost.

As long as the support price is above the world price, the quantity exported under subsidy should be the same, regardless of the support price. The amount of the subsidy would be lower with the lower support price, but this is accounted for by the lower initial acquisition cost.

When subsidies are paid in cash, as they are now for exports of wheat

flour, they are not included in the above calculation of Treasury cost; therefore the cash subsidies should be added to my previous estimates. In the fiscal year 1959, these cash subsidies amounted to about 30 million dollars.[6] With the support price lowered to $1.68, the cash subsidies would have been only about 23 million dollars.[7] Thus, about 30 million dollars should be added to my previous estimate of the present program, and about 23 million dollars to the estimate under Eisenhower's program.

(c) *Average yield would be lowered by ending acreage restrictions.* The available data are insufficient to prove this point either way. There certainly doesn't seem to be any correlation between number of seeded acres and yields on the national aggregate level. In fact, yields seem to show an upward trend from technical changes and a year-to-year fluctuation from the weather variations.[8]

Mr. Rice thinks that the national average yield would be lowered by an expansion of wheat acreage into areas with few alternatives and wheat yields below the national average. He doesn't indicate where these areas are, but I suppose he had in mind the winter wheat area in the Southern Plains. In 1958 this area had a wheat yield that was higher than the national average.[9] In the *Farm Costs and Returns* data there are seven classifications of wheat farms. Three of these classifications had yields higher than the national average in 1958, yet these were the only three that derived over 50 per cent of their cash receipts from wheat—an indication that they have few alternatives. In previous years one of the three classifications had yields lower than the national average (the winter wheat farms in the Southern Plains); nevertheless, even though this is a large wheat-producing area, the effect on the national average yield from a nation-wide increase in 14 million wheat acres would be very small.

Wheat acreage would tend to expand rapidly in the Corn Belt since wheat is the most profitable nurse crop. This area usually has yields higher than the national average. The same would be true in other areas that require a nurse crop but have had to plant something else because of the wheat allotments.

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[6] See "Report of the President of the Commodity Credit Corporation, 1959," U. S. Dept. of Agr.; and "Report of Financial Condition and Operations as of June 30, 1959," Commodity Credit Corporation, U. S. Dept. of Agr.

[7] The average subsidy per bushel in the fiscal year 1959 under the International Wheat Agreement amounted to 56 cents (see reference in footnote 6). If the support price dropped to $1.68 from $1.82, the subsidy would drop about 14 cents, to 42 cents per bushel—a drop of about 25 per cent. Total subsidies would drop about 25 per cent—to 23 million dollars.

[8] See the acreage and yield data in *The Wheat Situation,* Agr. Marketing Serv., U. S. Dept. of Agr.

[9] See *Farm Costs and Returns,* Aug. 1959, Agr. Info. Bul. No. 176, U. S. Dept. of Agr.

(d) *Wheat Treasury cost would be partially offset by savings from acreage changes in other supported crops.* The only cost I computed was the wheat Treasury cost. It is true that any savings accruing to other programs from operation of the wheat program should be subtracted from the wheat cost. That seems to be a valid point, but such "savings" would not be very great. In the fiscal year 1959, the net Treasury cost for supporting the six crop alternatives mentioned by Mr. Rice (sorghum, oats, barley, corn, flax, and rye) was about 742 million dollars,[10] and the acreage planted in these crops was about 158 million acres.[11] The cost per acre was about $4.70. If the acreage of these crops decreased by the amount of the estimated increase in wheat acreage—14 million—the "savings" to the government would have been only about 66 million dollars (14 million acres multiplied by the cost per acre).[12]

Thus, when the cash subsidy payments are added and the reduction in costs for other crops is subtracted from my previous estimate, it remains about the same. If a less conservative estimate of acreage response had been used, my cost estimate would have been higher.

[10] The CCC report on financial operations, *op. cit.* Estimated by adding the change in inventory to the value of dispositions, and then subtracting dollar sales. The inventory and dispositions are valued at cost, which includes storage expense.

[11] Taken from *Crop Production, 1959 Annual Summary,* Agr. Marketing Serv., U. S. Dept. of Agr.

[12] This estimate is highly approximate since it assumes that acreage ratios of the six crops after the decrease in acreage would be the same as before.

FACTORS AFFECTING GROSS FARM INCOME PER WORKER, UPPER EAST TENNESSEE VALLEY, 1899-1954

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"We all live in a state of ambitious poverty."
—JUVENAL, *Satire III*

Introduction

ABOUT three years ago, I published an article[2] which was concerned with the effects during 1900-1950 of industrial development on the agriculture of a 20-county area in the Upper East Tennessee Valley, some of whose counties had enjoyed a rapid rate of industrialization while

[1] I am grateful to my colleague, Anthony M. Tang, for comments and criticisms; and to the Rockefeller Foundation for its grant in support of the larger project of which this research is a part.

[2] Nicholls, "The Effects of Industrial Development on Tennessee Valley Agriculture, 1900-1950," *J. Farm Econ.*, 38:1636-49 (1956). Cf. my article, "Industrial-Urban Development and Agricultural Adjustments, Tennessee Valley and Piedmont, 1939-54," *J. Pol. Econ.*, April 1960.

other similar nearby counties had remained almost wholly rural and agricultural. In that article, I sought to measure the extent to which a large number of agricultural attributes were associated with the level of county industrial-urban development in selected census years. My principal tool of analysis was rank-correlation (Spearman) rather than variate-correlation (Pearson) techniques and all of my statistical inferences were based upon simple rather than partial correlation coefficients. While I chose the simpler rank-correlation analysis mainly because of economies of computation, I felt that the use of this particular method was further justified on the basis of the crudeness of my data, the small number of county observations, and the failure of most of my data to fulfill the assumptions implicit in parametric techniques.

In any case, the rank-correlation technique produced results which made clear that (a) by the 1940's the more industrial-urban counties had numerous agricultural attributes which differed significantly from those of the less advanced counties of the same study area; and (b) since 1900 these differences had substantially widened as certain counties industrialized more rapidly than their neighboring counties. Upon the basis of these findings, I concluded that industrial-urban development—through its favorable effects on the efficiency of local factor and product markets—was an important *causative* factor in raising the relative per-worker farm incomes of the more industrial counties.

Even so, it appeared to be wise to narrow down my many agricultural indexes to a number more suitable for statistical analysis by orthodox multiple-correlation techniques of the original data rather than their ranks. Furthermore, the *net* as well as gross effects of industrial-urban development upon per-worker farm incomes are also of considerable interest, suggesting the importance of computing partial as well as simple correlation coefficients. To this end, I decided to take gross farm income per "worker"[3] as my dependent variable and selected four independent variables that seemed likely to account for a major part of the variance in per-worker farm income. In addition to per-capita non-agricultural payrolls (my index of industrial-urban development), these independent variables included farm capital per worker (to reflect factor combina-

[3] This index is more than an index of per-capita farm income since, at least for 1940-54 (see footnote *a*, Table 1), I have defined "number of farm workers" in terms of the estimated quantity (in units of man-year equivalents) of residual labor inputs available for farm work, after making adjustments for off-farm employment and other factors. At the same time, gross farm income per "worker" (thus defined) is only a crude index of farm-labor productivity since the numerator is merely gross value of farm income (including home-produced food consumption) rather than an index of total physical production of farm products. As a consequence, the relative gross farm incomes of different counties might vary, because changing relative prices were applied to different constant product mixes, without any change in the output of any of the product components.

tions), an index of total inputs per farm (which may be viewed as a crude index of relative farm scale), and tobacco production per 1000 acres of cropland. The resulting coefficients of simple, partial, and multiple correlation for selected years 1899-1954 are presented in Table 1. In recognition of certain peculiarities of three of my twenty counties,[4] I have also consistently computed correlation coefficients for a 17-county group (excluding these three counties) as well as for the full 20-county group. Finally, for 1949-50 only, I have taken advantage of the census breakdown of all farms into commercial and other (part-time and residential) farms by treating the two classes of farms separately as well as combined.

Trends in the Simple Correlation Coefficients

Let us look first at the simple correlation coefficients.[5] Throughout 1899-1954, there was a very high positive correlation (in part spurious because of denominators in common) between per-worker gross farm income and per-worker farm capital (r_{12}). From 1939 on, per-worker farm income was also strongly associated positively with per-capita non-agricultural payrolls (r_{13})—a relationship which was substantially greater on part-time than on commercial (full-time) farms. Throughout the period, gross farm income per worker was positively associated, in varying degrees, with

[4] Because of their peculiar agricultural attributes, the inclusion of Russell, Carter, and Unicoi counties rather persistently produced lower coefficients of correlation between industrial-urban development and various agricultural indexes (those for part-time farms often excepted) than if they were included. Primarily because of its relatively large farms, low fertility rates, and heavy livestock investments, Russell county has historically been able to maintain relatively high per-worker farm income despite its almost total absence of industrial development. On the other hand, with relatively high levels of industrial-urban development, Carter and Unicoi counties have nonetheless succeeded in raising their per-worker farm incomes only very slowly because of relatively very small farms, rugged terrain, high fertility rates, and low livestock investments.

[5] It should perhaps be noted that, in all previous analyses of the interrelationships between industrial-urban development and agriculture in the Tennessee Valley, I restricted my attention to the *rank* correlation coefficients corresponding to r_{13}, r_{23}, r_{34}, and r_{35} in Table 1. Furthermore, the values of the r's of Table 1 are almost invariably smaller than the corresponding *rho*'s of previous analyses whereas, if the values of the series correlated were normally distributed, r would always exceed the corresponding *rho*. In fact, however, these series (particularly the index of industrialization) depart substantially from a normal distribution. Under these circumstances, where there is a positive relationship for all counties between X and Y, if a particular county has an extremely high X value but an extremely low Y value, the inclusion of this county will substantially lower Σxy and increase $N\sigma_x\sigma_y$, hence lower r much more than the corresponding *rho*, which minimizes the extremeness of that county's X and Y values. The fact that the relationships studied are not always strictly linear also tends to result in lower r values, since the Pearsonian correlation assumes linear relationships as compared with the broader assumption of monotonic relationships employed in the rank technique. It is apparently for these reasons that these r's generally fall short of the corresponding *rho*'s.

TABLE 1. SIMPLE AND PARTIAL COEFFICIENTS OF CORRELATION (PEARSONIAN) BETWEEN GROSS FARM INCOME PER WORKER (X_1) AND FARM CAPITAL PER WORKER (X_2), PER-CAPITA NON-AGRICULTURAL PAYROLLS (X_3), INDEX OF TOTAL INPUTS PER FARM (X_4), AND TOBACCO PRODUCTION PER 1000 ACRES OF CROPLAND (X_5), 20-COUNTY UPPER EAST TENNESSEE VALLEY STUDY AREA, SELECTED YEARS, 1899–1954[a,b]

Correlation Coefficient	No. of Counties	All Farms					1949–50	
		1899–1900	1929–30	1939–40	1949–50	1954	Commercial	Other
r_{12}	20	.781**	.783**	.906**	.828**	.806**	.898**	.732**
	17	.688**	.852**	.913**	.921**	.880**	.937**	.924**
r_{13}	20	−.065	.007	.518*	.587**	.580**	.415*	.769**
	17	.169	.620**	.703**	.747**	.617**	.704**	.780**
r_{14}	20	.390*	.695**	.262	.601**	.459*	.694**	−.089
	17	.521**	.618**	.191	.644**	.580**	.758**	−.142
r_{15}	20	−.047	.309	−.222	−.484*	−.596**	−.467*	−.408*
	17	−.124	.214	−.246	−.500*	−.762**	−.616**	−.476*
r_{23}	20	.409*	.532**	.753**	.767**	.771**	.496*	.850**
	17	.685**	.833**	.880**	.810**	.757**	.715**	.839**
r_{24}	20	.690**	.637**	.109	.282	.208	.769**	−.052
	17	.757**	.611**	.136	.392	.377	.758**	−.054
r_{25}	20	.033	.030	−.359	−.647**	−.668**	−.562**	−.545**
	17	.056	.009	−.344	−.639**	−.793**	−.633**	−.542**
r_{34}	20	.663**	.095	−.401*	−.044	.081	.477*	.092
	17	.724**	.478*	−.074	.284	.133	.706**	.131
r_{35}	20	.192	−.269	−.448*	−.526*	−.565**	−.526*	−.526*
	17	.217	−.064	−.345	−.503*	−.624**	−.503*	−.503*
r_{45}	20	.218	.098	.254	−.125	−.492*	−.540**	−.027
	17	.300	−.028	.166	−.268	−.416*	−.648**	−.047
$r_{12.345}$	20	.822**	.848**	.868**	.617	.682**	.786**	.186
	17	.680**	.725**	.855**	.907**	.681**	.818**	.764**
$r_{13.245}$	20	−.627**	−.703**	−.480*	.234	−.082	−.047	.446*
	17	−.634**	−.274	−.503*	.080	−.036	.069	.116
$r_{14.235}$	20	.049	.229	−.107	.698**	.494*	.041	−.275
	17	.392	.262	−.094	.835**	.522*	.159	−.259
$r_{15.234}$	20	.257	.349	.129	.105	.122	.087	−.079
	17	−.243	.397	.169	.510*	−.131	−.018	.063
$R^2_{1.2345}$	20	.803	.872	.885	.843	.743	.809	.632
	17	.703	.802	.882	.958	.849	.884	.864
$R_{1.2345}$	20	.896	.934	.941	.918	.862	.900	.795
	17	.839	.895	.939	.979	.921	.940	.930

* Significant to 1% level.
** Significant to 5% level.

[a] *Gross farm income* is the combined value of farm products sold or produced and consumed on farm as reported by the various Censuses of Agriculture except that, for 1949 and 1954, the county values of home-produced consumption were estimated. *Farm capital* includes the value of land and buildings, livestock, implements and machinery, and (except 1900 and 1930) working capital as reflected by selected production expenditures—all as reported by the Censuses of Agriculture. County values of machinery and certain production expenditures were estimated for 1949–50 and 1954 and county values of livestock were estimated for 1954. *The number of farm workers* is my estimate of the rural-farm male population 15 years and over in each county for 1900 and 1930; and the enumerated or estimated total farm population aged 15 and over, adjusted downward for off-farm employment and school attendance—and, for females, also adjusted for lower productivity and lower labor-force participation—for 1940–54. Thus, for 1940–54, I have attempted to estimate available farm-labor inputs in terms of "man-year equivalents."

Non-agricultural payrolls includes payrolls (by places of employment) originating in the manufacturing, retail, wholesale, and selected service industries as reported by the censuses of manufactures and business for 1939–54. For 1899 and 1929, since most payroll data were not available, *value added by manufacture* was used instead. For placing these series on a *per-capita* basis, population was as reported by the census or interpolated therefrom.

The *index of total inputs per farm* (a crude index of relative farm scale) for each county was obtained by computing the sum of that county's ranks in workers per farm and capital per farm and subtracting that sum from 40 (or from 34 for 17 counties), which was the maximum sum possible if that county ranked *last* in both indices. By subtraction smaller values of the index were made to correspond to smaller—rather than larger—scale operations. Unlike in the rank-correlation analysis of my earlier studies, the sums of ranks were themselves used here as observations rather than reranked, with the new ranks being used as observations. The (for purposes of variate correlation analysis) peculiar nature of this particular variable should be noted.

Tobacco production is total pounds of tobacco leaf produced in each county. For purposes of inter-county comparablity, converted to the basis of *per 1000 acres of cropland harvested* (for 1899 only, per 1000 acres of improved land) as reported by the census.

[b] The *study area* (approximating the state of Massachusetts in area) included the following 20 counties, listed in the descending order of their per-capita non-agricultural payrolls in 1954: Sullivan, Hamblen, Smyth (Va.), Carter, Washington (Va.), Greene, Washington (Tenn.), Unicoi, Cocke, Jefferson, Sevier, Hawkins, Scott (Va.), Russell (Va.), Claiborne, Lee (Va.), Johnson, Grainger, Union, and Hancock. (All counties in Tennessee unless otherwise noted.) Coefficients for *17 counties* exclude Carter, Unicoi, and Russell.

total inputs per farm (r_{14}), the low point of 1939-40 probably reflecting the combined influence of the depression-caused backing up of surplus labor on the area's farms and the initial fragmentizing effects of industrialization on relative farm size before further industrial development began to facilitate positive scale adjustments within the commercial (but not part-time) sector of agriculture. Finally, although per-worker farm income was positively associated with relative tobacco production in 1929-30, the relationship (r_{15}) became increasingly negative during 1939-54, as the more developed counties shifted more heavily toward livestock production.

The simple coefficients of correlation between independent variables are also worth comment. Per-worker farm capital was invariably strongly associated not only with per-worker farm income but increasingly so (particularly on part-time farms) with level of industrialization (r_{23}) as well. The tendency for a favorable capital-labor ratio to be associated with relatively larger-scale (primarily commercial) farming operations (r_{24}) declined sharply up to 1939-40, but partially recovered thereafter during a period when per-worker capital showed a large *negative* correlation with relative tobacco production (r_{25}). Level of industrial development was not only strongly associated with per-worker farm capital and (after 1929-30) per-worker farm income, but was increasingly correlated *negatively* with relative tobacco production (r_{35}). The relationships between industrial development and total inputs per farm (r_{34}) shifted from strongly positive to strongly negative during 1899-1940, after which it became neutral for all farms but significantly positive for commercial farms only. Finally, as tobacco production spread over the area as the principal staple cash crop, it was increasingly correlated negatively with not only per-worker income and capital and industrialization but with relative scale of (primarily commercial) farming operations (r_{45}) as well.

Net Influence of Selected Factors on Productivity

But what of the *net* influence of these several factors (particularly industrialization) on gross farm income per worker? Throughout 1899-1954 —even if we hold constant the level of industrialization, relative scale of farm, and relative tobacco production—the dominant determinant of per-worker farm income was per-worker farm capital ($r_{12.345}$) although, after reaching a peak in 1939-40, the relationship was somewhat weaker thereafter as relative scale of farm (other things remaining equal) suddenly assumed a position of almost equal influence ($r_{14.235}$).[6] During 1899-

[6] It should be noted, however, that in 1949-50 the partial correlation between farm-labor productivity and index of total inputs per farm (relative farm scale), while very high for *all* farms, was very low for commercial and part-time farms separately.

54 the net effect of relative tobacco production on gross farm income per worker ($r_{15.234}$) was significant in only one instance (17 counties, 1949-50) and, with this single exception, the earlier moderate tendency toward a positive effect entirely disappeared from 1939-40 on.

However, most interesting for present purposes, the level of industrialization (the other factors being held constant) at no time—with the exception of part-time farms in 1949-50—had a positive *net* effect on per-worker farm income ($r_{13.245}$). Indeed, prior to 1949-50 this net effect was strongly *negative* although, by 1949-54, it was at least neutralized. Does this finding invalidate our major hypothesis concerning the favorable influence of industrial-urban development (via the labor and capital markets) on farm-labor productivity? I believe not, since the *net* effect of industrialization is that which remains after allowing for its favorable effects on factor combinations (X_2) and relative scale of farming operations (X_4), which in themselves reflect the results of the less imperfect capital and labor markets in the more industrial counties.

Having thus allowed for the favorable indirect effects of industrialization on farm-labor productivity, we perhaps should not be surprised that the remaining effects of industrialization were adverse to high productivity. For example, off-farm employment of farm people tends to select those in the most productive age groups (a factor which our farm labor force estimates fail to take into account) and, other things being equal, farm efficiency probably tends to suffer as the role of farming is increasingly subordinated to that of non-farm activities. Under such circumstances, we may wonder why this net negative effect of industrialization has been neutralized in recent years. The most plausible reason would appear to be the salutary effects of industrialization on the competitiveness and efficiency of local *product* markets, whereby the farmers of the more developed counties are able (a) to get higher prices for particular products (and to pay lower prices for particular inputs), (b) to make income-raising product innovations which are the result of local urban growth, and (c) are able to market larger proportions of certain farm products (e.g., milk) in forms commanding higher prices (fluid milk). These advantages are reflected in higher value productivity in the more industrial counties even if their physical productivity is no higher.[7]

Conclusion

In this note I have sought to determine, by the use of Pearsonian multiple-correlation analysis, the net effects of selected factors (including industrialization) on gross farm income per worker in the Upper East

[7] Cf. Anthony M. Tang, *Economic Development in the Southern Piedmont: Its Impact on Agriculture*, Univ. of North Carolina Press, Chapel Hill, 1958, p. 110.

Tennessee Valley. Here, I found that, holding the level of industrialization and other factors constant, the dominant determinant of per-worker farm income throughout 1899-1954 was per-worker farm capital although, after 1939-40, relative scale of farm (total inputs per farm) assumed a position of almost equal importance. Obviously, industrialization had favorable effects, by making for less imperfect labor and capital markets, on both factor combinations and scale of farm. But, after allowing for these favorable indirect effects of industrialization on per-worker farm income, the *net* effect of industrialization initially tended to be strongly adverse. Since 1939-40, however—probably due to the salutary effects of further industrialization on the competitiveness and efficiency of local *farm product* markets—even this adverse net effect of industrialization on productivity has been almost wholly neutralized.

THE RELATIONSHIP OF VOLUME, PRICES AND COSTS TO MARKETING MARGINS FOR FARM FOODS*

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THIS study applies ordinary least squares regression to annual and quarterly data for 20 commodities in an attempt to determine the relation of farm-retail price spreads for individual foods to the average spread for all foods collectively and to the volume, retail price and change in price of the individual foods. The statistical model for both the annual and quarterly analyses is:

$$(1)\quad Y_i = a_i + b_{i1}X_1 + b_{i2}X_{2i} + b_{i3}X_{3i} + b_{i4}X_{4i} + b_{i5}X_5 + b_{i6}X_6 + U_i$$

where:

Y_i = marketing margin for commodity i

X_1 = farm-retail spread for the market basket of farm foods (MBM)

X_{2i} = civilian disappearance or per capita consumption of commodity i, adjusted for trend

X_{3i} = retail price of commodity i, adjusted for trend and price level

X_{4i} = price direction indicator for commodity i

X_5 = linear measure of time (1, 2, 3, · · · , t) with its origin at 1920. (Not included in the analysis of quarterly data.)

* This report is based upon a part of an unpublished Ph.D. dissertation, Rueben C. Buse, "The Relationship of Marketings, Prices and Costs to Marketing Margins for Farm Foods," Pennsylvania State University, 1959.

X_6 = linear measure of time for the post-war period, with its origin at 1946 for annual data and at the last quarter of 1946 for quarterly data.

U_i = error term for commodity i

The price direction indicator for each commodity (PDI_i) for each year or quarter was calculated as follows:

$$PDI_i = \sum_{j=2}^{12} P_{ij} - 11P_{i1} \text{ (annual)} \tag{2}$$

$$PDI_i = \sum_{i=2}^{3} P_{ij} - 2P_{i1} \text{ (quarterly)} \tag{3}$$

where:

P_{ij} = retail price of commodity i in month j

P_{i1} = retail price of commodity i in January or first month of the quarter

Standard time series published by the U.S.D.A. were used to represent the variables in equation (1).[1] The annual series had the same terminal year, 1957, but began in different years during the period 1921-1935. For potatoes and apples, the data were converted to a crop year comprised of twelve months beginning July 1 for potatoes and six months beginning October 1 for apples. For the quarterly data, all the series began with the first quarter of 1947 and ended with the last quarter of 1957, except that the series for food fats and oils began with the third quarter of 1948.

The years 1942-46 were excluded from the analysis because of the effect of wartime price controls on margins. Preliminary analysis of annual data revealed that for some commodities the effect of time on the marketing margin was different in the post-war period than in the years before 1941. In these cases, the equations to be estimated included a second trend variable for the post-war years.

All the quarterly data were adjusted for changing seasonality as well as for trend and price level. The trend effect due to a changing seasonal pattern was also eliminated from the price direction indicator.

The Results

To permit a direct comparison of results for one commodity with results for another, the regression coefficients were converted to percentage units,

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[1] Margins and retail prices are described in *Farm-Retail Spreads For Farm Products*, U.S.D.A. Misc. Pub. No. 741, AMS, November, 1957. As the publication indicates (p. 66), the retail price series are computed by a linking method. Probably this removed from margins much of the effect of marketing services that change the form and price of the retail unit.

TABLE 1. REGRESSION COEFFICIENTS COMPUTED FOR EQUATION (1) BUT EXPRESSED IN ELASTICITY FORM, AND COEFFICIENTS OF MULTIPLE DETERMINATION, ANNUAL DATA

Commodity	Per cent change in margin associated with a one per cent change in—						
	MBM X_1	Volume X_2	Price X_3	PDI X_4	Time[1] 1921–41 X_5	Time[1] 1947–57 X_5 & X_6	$\bar{R}^2$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Beef	.68**[2]	−.20	.22	−.010	.03	2.75	.96
Pork	.96**	−.17	.05	−.013	−.39	.62	.95
Lamb	.89**	.44**	.75**	−.024**	−.58**	2.79	.97
All meat	.78**[2]	−.13	.41*	−.004**	−.06	2.01	.98
Butter	1.44**[2]	.18	.44**	−.006	−1.26**	−4.29	.98
American cheese	1.15**[2]	−.36*	.52	−.026**	.34**	[3]	.98
Dairy products	.88**[2]	−.24	.58**	−.001	.52**	1.48	.998
Eggs	.96**	.76**	.30	−.009	.77**	−3.73	.97
Chicken	.67**	.62*	1.26**	.011	1.55**	−.73	.96
Vegetable shortening	.59**[2]	−.01	.87**	−.033**	.08	−.47	.90
Apples	.83**	−.33	.31	.012	.41	[3]	.98
Oranges	1.23**[2]	.27**	.54**	−.023	−2.20**	−.97	.98
Potatoes	.70**[2]	[4]	.39**	−.010	−.17	5.61	.99
Lettuce	.62**	−.42	.58*	.001	.65	[3]	.97
Onions	1.05**	.43**	.59**	−.015	−.34	[3]	.98
Cabbage	1.09**	.36**	.56**	.004	−.29*	[3]	.99
Canned peaches	1.23**	−.02	.38	.006	.09	−3.95	.97
Canned tomatoes	1.15**	−.16*	1.31**	.005	−.14	−2.67	.98
Canned corn	1.14**	.08	1.05**	.021**	−.55**	−2.88	.99
Canned peas	1.17**	−.11*	.96**	.008	.89**	−4.73	.98

* Regression coefficient significant at .05 level.
** Regression coefficient significant at .01 level.
[1] Average per cent change in margin per annum evaluated at the mean of margins. For the post-war period the regression coefficients were combined as a basis for computing the elasticities. No variances were computed for these elasticities.
[2] Significantly different from 1.00 at the .05 level.
[3] Same as for X_5; only one trend computed.
[4] Within .005 of zero.

or elasticities, evaluated at the means of the data.[2] The estimated equations in terms of elasticities, the significance level of the regression coefficients from which the elasticities were calculated, and the adjusted

[2] The procedure for computing elasticities of margins with respect to MBM, volume, and retail price was the same as that for a demand or supply elasticity. Since the dating of time is arbitrary, the elasticity with respect to time was computed by dividing the average change in the margin per unit of time by the average margin. The PDI could be negative as well as positive, and the algebraic mean usually was close to zero. To avoid the erratic elasticities resulting from this, the values of PDI were summed without regard to sign, and the average was used to evaluate the percentage change in margin associated with a one per cent change in the PDI.

TABLE 2. REGRESSION COEFFICIENTS COMPUTED FOR EQUATION (1) BUT EXPRESSED IN ELASTICITY FORM, AND COEFFICIENTS OF MULTIPLE DETERMINATION, QUARTERLY DATA, 1947–57

Commodity	Per cent change in margin associated with a one per cent change in—					
	MBM X_1	Volume X_2	Price X_3	PDI X_4	Time[1] X_6	$\bar{R}^2$
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Beef	2.55**[2]	.07	.30	−.024*	−.67	.83
Pork	.67*	.51*	.18	−.011	.45*	.87
Lamb	1.02	.55**	1.08**	−.016	.39	.84
All meat	2.15**[2]	.11	.35	.002	−.35	.93
Butter	1.03**	−.21*	.30*	−.002	−.33	.65
Dairy products	.73**	−.21	.07	−.009**	.37**	.97
Eggs	.92**	.96**	[3]	.005	−.70**	.28
Food fats and oils	.30	.08	.66**	−.023**	−.51*	.69

* Regression coefficient significant at .05 level.
** Regression coefficient significant at .01 level.
[1] Average per cent change in margin per annum evaluated at the mean of margins.
[2] Significantly different from 1.00 at the .05 level.
[3] Within .005 of zero.

coefficients of multiple determination are presented in Table 1 for the annual data and in Table 2 for the quarterly data.

The Durbin-Watson test for serial independence of residuals was inconclusive at the .025 level of significance for the majority of both the annual and quarterly equations. The possible serial correlation of the residuals leads one to suspect that the *t*-test may overstate the reliability of the coefficients or elasticities.

$\bar{R}^2$ was found to be well over .90 in the analysis of annual data for almost all of the commodities. The squared gross correlations between Y_i and X_1 exceeded .85 in most instances, as would be expected since neither the commodity margins nor the MBM was adjusted in any way. Dropping other variables from the equation usually affected $\bar{R}^2$ very little.

Individual margins and the MBM

The uniformly strong relation between individual margins and the MBM is useful information, for the items making up an average do not necessarily vary closely with it over time. That 12 of the 20 elasticities for annual data were not significantly different from unity indicates a tendency for individual margins to vary in the same proportion. Elasticities for quarterly data were more erratic than for the annual data but did not give evidence of a different type of relationship.

A large amount of evidence supports the conclusion that "Changes in [farm-retail price] spreads over a period of time are determined pri-

marily by changes in costs of all factors employed in processing and distributing operations."[3] Especially since 1941, the MBM has been highly correlated with the Bureau of Labor Statistics index of wholesale prices of commodities other than farm products and foods and with a "manufacturing margin," roughly analogous to the MBM, computed by dividing national income originating in manufacturing by the Federal Reserve index of the physical volume of manufacturing production. Over the whole period, the MBM apparently represented better than any other single series the combined influence of wages, prices of industrial materials, and productivity in marketing as they affected marketing costs.[4] Moreover, it best accounted for a set of influences that otherwise would have distorted the apparent relation of individual margins to volume, retail price and price change.

Margins and volume

A special problem arises in interpreting the coefficient of volume in (1) since the equation also contains retail price. The volume elasticities must be interpreted as the effect of a change in volume on the marketing margin when retail price is held constant. This interpretation of the volume elasticity is contrary to the usual market structure because retail price must change when volume changes, other things being equal. Including both volume and price in the same equation complicates the interpretation of their coefficients but frees other coefficients of influences arising from correlation of volume or price with the other variables. The volume elasticities in Table 1 vary widely, and about half are positive and half negative.

The equations were re-computed with retail price (X_3) omitted from (1). The resulting annual volume elasticities (Table 3) still varied considerably, but 6 of the 7 statistically significant ones were negative. Detailed examination of the egg data revealed clustering effects that detracted from confidence in the apparently significant, positive elasticity.

The quarterly data present a very mixed picture. Estimates of civilian disappearance on a quarterly basis are so subject to error that the results must be interpreted with great caution. The significant positive elasticity for pork agrees with Breimyer's findings for a similar period.[5] The large

[3] *Farm-Retail Price Spreads . . ., op. cit.*, p. 3. Undoubtedly, some variations in margins not related to costs have been caused by administrative pricing and by short-term lack of equilibrium in processing and distribution.

[4] One set of computations was made with wholesale prices of commodities other than farm products and foods replacing the MBM. Relationships were not much different, but the variances and serial correlation of residuals were higher.

[5] Harold F. Breimyer, "On Price Determination and Aggregate Price Theory," *J. Farm Econ.*, 39:691-2, Aug. 1957.

TABLE 3. MARGIN-ON-VOLUME AND MARGIN-ON-PRICE ELASTICITIES[1] OBTAINED WHEN PRICE AND VOLUME, RESPECTIVELY, ARE OMITTED FROM EQUATION (1)

Commodity	Margin-on-volume elasticity, price omitted from equation (1)		Margin-on-price elasticity, volume omitted from equation (1)	
	Annual data	Quarterly data	Annual data	Quarterly data
Beef	−.36**	.01	.45**	.06
Pork	−.21	.34**	.21	−.24*
Lamb	.10	−.05	.30	.33
All meat	−.39**	−.16	.51**	.25*
Butter	−.02	−.33**	.36**	.44**
American cheese	−.42**		.68*	
All dairy products	−.30	−.21	.60**	.08
Eggs	.65*	.96**	.16	−.12
Chicken	.04		1.05**	
Food fats and oils		.04		.66**
Vegetable shortening	.04		.87**	
Apples	−.55*		.50*	
Oranges	.14		.37**	
Potatoes	−.44*		.39**	
Lettuce	−.51*		.68*	
Onions	.20		.55**	
Cabbage	.02		.42**	
Canned peaches	−.14		.40	
Canned tomatoes	−.23		1.33**	
Canned corn	−.03		1.00**	
Canned peas	−.14		.98**	

* Regression coefficients significant at the .05 level.
** Regression coefficients significant at the .01 level.
[1] Percentage change in margin accompanying a one per cent change in volume or price.

positive elasticity for eggs is due mainly to a high margin and large volume relative to trend in the years 1950-52 but agrees with the elasticity found in the annual data.

Margins and retail prices

As Tables 1 and 2 show, the marketing margin was positively related to retail price for every food in both the annual and quarterly analyses when volume was included in the regression equation. When volume was dropped from the equation, the elasticities obtained from annual data (Table 3) were slightly more uniform and more frequently statistically significant. Most of the annual elasticities of Table 3 range from .30 to .70.[6]

[6] It might be noted that the margin-price relationship studied here is conceptually different from the gross margin-price comparisons frequently made in the past. When annual margins and prices are compared over a period like 1921-57, the observed relation is very much affected by the fact that the major changes in food prices and mar-

The quarterly price elasticities (Table 3) are erratic. Those for eggs and pork are negative, which is consistent with the significant, positive volume elasticities for these products.

The retail price can properly be considered uninfluenced by the margin (as the model implies) if the quantities marketed and consumed in a particular year are identical and predetermined. Then the retail price under most competitive circumstances will move to a level that clears the market of production under existing demand conditions, and the farm price in that year will be a residual remaining after the marketing margin is subtracted. This approximates the situation for several food products. But for other foods, changes in inventories (including government stocks), or in foreign trade, or quick responses of production to price may permit an independent change in the margin to influence the retail price in the same year.

When the farm price in a particular year is a residual, changes in the margin for reasons other than retail price will not affect the retail price. If the margin changes with retail price because of retailers' tendency to apply constant percentage markups or for other reasons, the elasticity of margin on price might be expected to be distinctly less than unity. But in situations where an independent change in marketing costs or competitive circumstances cause a change in the retail price with little effect on the farm price—and this may be common for such products as canned foods, vegetable shortening and cereals—the percentage change in margin can readily exceed the percentage change in retail price. The high margin-on-price elasticities for several foods suggest a mixture of the two situations.

Margins and the price direction indicator

Except for canning crops, rising prices during the year tended to reduce margins below their average level, although the relation was not strong enough to produce statistically significant coefficients for the PDI for most commodities. All of the canning crops have positive elasticities, and one of these is statistically significant. The grower price for canning crops is usually established by contract early in the season, and changes in retail prices during the season produce similar changes in computed marketing margins.

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gins were only particular aspects of inflation and deflation in the total economy. The relations presented here are net of the influence of the MBM and retail food price level and are more applicable to the question of how margins are related to prices when exogenous forces are acting upon the individual commodity but not upon the whole economy or the whole food sector.

Margins and trend

The time elasticities convey little useful information because statistically significant values might arise from any of a number of causes. Changes in the efficiency of processing and distribution relative to the general level of efficiency for all foods collectively, or an aberrant change in the price of an input peculiar to some commodity, would be reflected in the trend coefficients. On the other hand, trend was removed from both volume and price, and a significant coefficient for X_5 in (1) might represent the effect of a deleted trend on the margin.

Discussion and Conclusions

In total, results leave much to be desired. The simple model probably does not closely represent the complex relationships existing in the markets for several foods,[7] some of the basic data may contain important errors of measurement, and probably relationships changed over the long period studied.

For most of the individual foods, 85 per cent or more of the total variation of annual margins was accounted for by changes in the average margin on all foods. Costs of processing and distribution apparently were the principal determinants of the over-all margin. Probably in a period of greater price stability, other variables would be relatively more important than in this period; but from the 1920's to 1957, volume, adjusted retail price, and change in price accounted for only about 10 per cent of the variation in individual margins.

The relation of margins to retail prices is clearly positive in annual data, but probably two types of situations are involved. When margins play a passive role and change only because prices change (when percentage markups are common in retailing or physical loss in marketing is high), the margin-on-price elasticity probably is low. But when margins play an active role—change because of costs or administrative pricing not based on costs—and when margins at least partly determine current retail prices, the elasticity obtained in a regression equation like (1) can be unity or higher. The negative or low elasticities in some quarterly data suggest that marketing firms sometimes are able to maintain greater stability of selling prices for a short time than they can maintain over a year.

The relation of margins to volume is especially important from a price policy standpoint but is the least clear of all. Changes in volume

[7] Considerable work was done with models that assumed simultaneous determination of margins for meats, but results were neither statistically significant nor reasonable in economic terms.

ordinarily induce opposite changes in retail prices, and margins are positively related to prices. But in this case, margins are playing the passive role, and the margin-on-volume elasticity would often be low, even zero. Strong evidence of a negative elasticity might not emerge through the haze of estimation errors and structural change that typically obscure relationships in this sort of analysis, especially since annual changes in volume of several commodities usually are small and sometimes are in response to current prices. Probably margins are more often negatively related to volume than Table 3 indicates, but the elasticities frequently are smaller than the margin-on-price elasticities would suggest.

Except for canning crops, rising prices (as distinguished from high prices) usually reduce margins, probably because retail prices typically lag behind farm prices.

The study concentrated upon relationships common to individual food products rather than upon particular commodity characteristics. Only in a few instances did intercommodity differences, though often large, seem to be significant and explainable. Studies of individual commodities, especially if the total marketing margin were subdivided into its component parts, probably would find and explain important commodity differences.

COMMENTS ON ECONOMIC OBSTACLES AND FARMERS' ATTITUDES TOWARD SOIL CONSERVATION PRACTICE ADOPTION

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IN THE November 1958 issue of this *Journal*, Prundeanu and Zwerman discussed factors that may influence the attitudes of New York farmers toward the acceptance of soil conservation practices.[2] In view of the expenditures by public agencies, such as the Soil Conservation Service and the Agricultural Conservation Program, this type of analysis can make a contribution if it increases soil conservation accomplishments relative to funds expended.

[1] The opinions expressed here are those of the authors and do not necessarily represent those of the Farm Economics Research Division, ARS, or the Department of Agriculture.

[2] "An Evaluation of Some Economic Factors and Farmers' Attitudes that May Influence Acceptance of Soil Conservation Practices," *J. Farm Econ.*, 40:903-14, Nov. 1958.

With a view toward encouraging further research into the acceptance and rejection of recommended soil conservation practices, we offer these suggestions on the Prundeanu-Zwerman analysis. First, a measure of soil loss appears desirable. Second, identification and measurement of the effect of economic variables on practice adoption requires further elaboration and refinement. Third, a sample encompassing both Soil Conservation District cooperators and non-cooperators would enlarge the universe to which the results can be inferred. Fourth, a definition of conservation applicable to particular land use practices remains to be developed. Fifth, the relationship between soil loss and net returns to farmers and the public should be ascertained. Sixth, further interpretation and clarification of the data are desired.

According to Prundeanu and Zwerman,

> For the second approach, the farmers in each of the three samples (Cayuga, Ontario, and Livingston) were divided in two groups, one high conservation group and one low conservation group.
>
> The high conservation group consisted of the farmers which had completed *more* than half of the soil conservation practices. The farmers who *had* completed *less* than half of the recommended practices belonged to the low group. Not the amount of the individual practice established but the over-all accomplishment of the respective farmer was considered this time.
>
> It is realized that this grouping appears to destroy information. After much discussion with farmers, soil conservation planners, and others, the 'high' and 'low' conservation groupings were decided upon. This was necessary because no common index of completion of practices has been arrived at in order to treat the dependent variable as a continuous variable.[3]

Apparently, the authors were seeking some measure of soil conservation accomplishment. Such a measure would have facilitated the analysis of the effects of economic factors on soil conservation practice adoption. Furthermore, such a variable would have focussed attention on those practices which actually contribute to soil erosion control. A weighting of practices according to their reduction in soil erosion would have discriminated out some of the related practices which were classified as soil conserving in the analysis.

With the use of the Browning equation,[4] soil loss for a sample of farms

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[3] *Ibid.*, pp. 904-5.

[4] Soil loss can be computed using the system of factors devised by Prof. George Browning, which take into account and weight various physical factors that affect erosion. These are soil type, crop management, vegetative cover (as expressed in terms of rotations), use or nonuse of contouring, terracing, stripcropping or listing, degree of slope, length of slope, extent of previous erosion, and a constant term. The weight given each factor is based on experimental data for the particular condition found. The product of the factors represents the estimate of the amount of soil lost from an acre in one year with normal weather. For example, in determining the annual erosion

can be treated as a continuous variable. Although the soil loss calculations are not as exact as might be desired, they are widely used in Midwestern States. The components of the Browning equation have been developed by agronomic research over the last several decades. Soil loss, calculated by means of the Browning factors, has been used as a continuous variable in our research in western Iowa for the past ten years.[5] The use of soil loss as a continuous dependent variable has enabled us to utilize a variety of statistical procedures. Possibly this general approach would be applicable to other parts of the nation, albeit the particular factors and values of factors might require revision.

Identification and measurement of the effect of economic variables on conservation practice adoption is a difficult undertaking. Prundeanu and Zwerman applied several statistical techniques in their investigation of these relationships.[6] With regard to the Ontario sample, the authors reported six of the 82 correlation coefficients between so-called economic factors and soil conservation practice adoption were significant at least at the 5 percent level. Yet, despite the 6 significant correlation coefficients they reached the conclusion that little if any relationship could be found between single economic factors and the number of practices adopted.

Although elaboration on this conclusion would be of interest, two possible reasons for their reaching this decision are apparent. First, when a large number of relationships are tested, it is expected that 5 percent

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loss for an acre of land, the factors are assigned a value in the following manner:

Factor	*Value*
Ida Soil type	1.5
10 percent slope	1.1
200 foot length of slope	1.7
corn, oats, meadow rotation	.9
little or no manure or fertilizer applied	1.3
0-25 percent of surface soil removed	.8
contour cultivation, surface planted	.6
constant term to transform the index to an estimate of tons of soil loss	8.0

Substituting these values into the formula:

(1.5) (1.1) (1.7) (.9) (1.3) (.8) (.6) (8) = 12.6 annual soil loss in tons per acre. If terracing with a value of .1 were substituted for contour surface planting which has a value of .6, soil loss would be reduced from 12.6 to 2.1 tons per acre per year. The Soil Conservation Service has a goal of reducing soil loss to 5 tons per acre per year on this soil. A 5 ton level of soil loss will allow sustained agricultural use of the land over time. For a detailed explanation of these factors, see "Browning's Erosion Factors," Iowa State College., Dept. of Agron. (Mimeo), 1948.

[5] See: John C. Frey, *Some Obstacles to Soil Erosion Control in Western Iowa*, Iowa Agr. Exp. Sta. Bul. 391, 1952; and R. Burnell Held and John F. Timmons, *Soil Erosion Control in Process in Western Iowa*, Iowa Agr. Exp. Sta. Bul. 460, 1958. The third inquiry in this series is near completion. The results will be published soon.

[6] Prundeanu and Zwerman, *op. cit.*, pp. 905-10.

of them could show a significant statistical relationship due to chance at the 95 percent level of probability. Consequently, in the case in point, 4 of the 6 significant relationships *might* have been due to chance. Second, due to the classification of economic variables the relationships between economic factors and the amount of soil conservation practices established might have been considered inconclusive. The logic of the cause and effect relationships might be questioned when cattle and contour farming; cattle and permanent fences; and permanent pasture and pasture improvement are correlated. We suggest that there might have been intercorrelation between these variables—both of which appear to be dependent upon still a third variable, rather than one being independent and the other dependent. Further refinement of the economic variables would have been helpful. Also it would have been useful to investigate the effect of all economic variables simultaneously in assessing the effects of economic factors on soil conservation practice adoption.

Further elaboration on the effect of economic variables on conservation practice adoption is necessary with respect to the pooled data. In analyzing all of their sample farms the authors divided them into a high and low conservation group. They reported, "The farmers of the high conservation group had smaller total farm acreage, less cropland, less land in permanent pasture, and much less land in woods than the farmers of the low group. This meant that there was a greater need for conservation to start with for the low group than for the high group."[7] It would be interesting to examine some of these factors in more detail. For example, why did the authors infer that small size of farm causes the adoption of a larger number of conservation practices? Are there sufficient logical reasons why less land in woods is a causal factor in determining the number of conservation practices adopted?

In comparing the high conservation group with the low one for the pooled data, the authors concluded that there was a greater need for conservation in the low group than in the high group. However, the most important characteristic of the farms was not mentioned, that is, the physical characteristics of the soil—the percentage of slope, the degree of erosion, the length of slope and the type of soil. These are very important factors which should be considered in deciding which group of farms has a greater need for conservation.

The Cornell study diagnosed the influences affecting soil conservation accomplishment only for Soil Conservation District cooperators. It is extremely difficult to isolate all influences on conservation practice adoption if the sample excludes non-cooperators. The results of a study can-

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[7] *Ibid.*, p. 907.

not be inferred to all farmers when the sample of district cooperators is used.[8] Therefore, selection of a sample encompassing both Soil Conservation District cooperators and non-cooperators would increase the use of research results such as these.

The lack of a widely accepted definition of conservation plagues research workers. Prundeanu and Zwerman accept as a definition of soil conservation "the sum total of practices recommended by the Soil Conservation planner in order to minimize hazards of soil erosion and to improve the productivity of the land."[9] A more complete statement of the practices recommended would have been helpful. In some parts of the United States soil conservation planners have numerous practices at their disposal for recommendation. Many of these practices can be substituted for each other within a considerable range of applicability. It would be of interest to know which combination of practices was recommended in New York and why particular practices were selected if others might have been substituted to achieve the same results.

While the authors certainly cannot be held responsible for the definition of conservation used by the Soil Conservation Service in the area, it would be well to realize the implications of such a definition. While some practices can be identified as soil conserving because they minimize the hazards of soil erosion, other practices—clearing land, open drainage, farm drainage, etc.—may not reduce the soil erosion hazard. The logic of including land productivity improving practices, which do not affect soil erosion, as soil conserving might be questioned. Particularly in reference to the question of governmental incentive payments for establishment of soil conservation practices does the definition of soil conservation practices become critical.

The relationship between soil loss and net returns to farmers and the public needs to be ascertained before public payments for the establishment of soil conservation practices can be justified from an economic viewpoint. The authors reported, "When a theoretical alternative of having extra money available to the amount of 10 to 20 percent of their total capital investment was introduced, most of the farmers would use some of this money for soil conservation practices."[10] This, they contend, stresses the importance of payments as incentives for farmers to establish soil conservation practices. However, does this assume perfect knowledge by farm operators about the costs and returns of conservation practices? Is it pos-

[8] For details about differences in Soil Conservation District cooperators and non-cooperators, see Loyd K. Fischer and John F. Timmons, *Progress and Problems in the Iowa Soil Conservation Districts Program*, Iowa Agri. Exp. Sta. Res. Bul. 466, 1959.

[9] Prundeanu and Zwerman, *op. cit.*, p. 910.

[10] *Ibid.*, p. 910.

sible that some conservation practices might be sufficiently profitable to alleviate the need for incentive payments if this information were made available to farmers? In our opinion one reason this type of educational information is not presented to farmers is that statistically reliable research concerning the costs and returns of conservation practices is not available. We believe that there is a serious lack of such information and, as a result, the importance of incentive payments cannot be stressed, particularly when these payments apparently extend into the area of private profitability. Perhaps these findings could be interpreted as an indication of the need for research and education about the relative profitability of soil conservation practices. However, this information is needed before public incentive payments can be justified from an economic viewpoint.

Further interpretation and clarification of the data in the Prundeanu-Zwerman article is needed. When discussing the pooled data in the body of the article they state, "The farmers of the high conservation group had smaller total farm acreage, less cropland, less land in permanent pasture and much less land in woods than the farmers of the low group."[11] However, in the summary the following appears: "Thus, the high conservation group has higher total acreage, more cropland, less land in woods, and received higher PMA payments."[12]

Based on the Prundeanu and Zwerman article and our experience with somewhat similar research, there appear to be two major problem areas preventing the adoption of soil conservation practices. One problem consists of the differences between public program objectives and farmers' objectives. In this area such things as lack of knowledge, uncertainty of consequences of practices, and failure to see the need for preventing soil erosion are important considerations. The other problem embraces obstacles preventing the farmer from accomplishing his own erosion control objective. Such things as the need for immediate income, lack of landlords' cooperation, and size of farm appear to be instrumental factors preventing the adoption of soil conservation practices.

As a result of the Cornell study and those we have completed in western Iowa, it appears that further research is needed along these lines: First, analyses of the cost and returns of alternative soil conservation practices are needed. Second, research is needed which will determine the role of conservation practices in the optimum allocation of resources by farm firms. Third, interdisciplinary research between economics, sociology, anthropology and psychology is needed to determine how farm operators arrive at their attitudes toward soil conservation practices. Fourth, empirical estimates of the quantity and location of future land resource needs

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[11] *Ibid.*, p. 907.
[12] *Ibid.*, p. 914.

are necessary. In light of public expenditures for soil conservation and the persistence of obstacles in preventing the application of conservation practices recommended in public programs, further studies along these lines would appear to be rewarding and timely.

A REPLY TO: "COMMENTS ON ECONOMIC OBSTACLES AND FARMERS' ATTITUDES TOWARD SOIL CONSERVATION PRACTICE ADOPTION"[1]

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BLASE and Timmons, in the preceding "Comment," state and elaborate six points. These will be discussed here in the order presented by them.

1. It is apparent that Blase and Timmons place great emphasis on soil erosion control as a measure of soil conservation accomplishments. The use of soil loss as a continuous dependent variable would unquestionably facilitate an economic analysis. This comparatively simple approach to a complex problem certainly has merit. Whether this is the answer, however, is still open to discussion.

Heady[3] has discussed the public and private aspects of production economics as related to soil conservation. It is worthy of note that his factor "Z" (see footnote 7, page 6) is not necessarily erosion control. Over twenty years ago Salter, Lewis and Slipher[4] proposed a "Soil Productivity Balance" for evaluation of the factor "Z" mentioned by Heady. Clearly soil erosion control and soil conservation are not the same in production economics. Erosion control may, certainly, be more nearly a correct definition for soil conservation in Iowa than in New York because two-thirds of New York State has little or no erosion while in Iowa this is true for only about one-third of the state.[5]

Values similar to the Browning equation have been published by Lloyd

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[1] Contribution from the Department of Agronomy, New York State College of Agriculture, Cornell University, Ithaca, N.Y. and the Department of Agronomy, National Agricultural College, Doylestown, Pa. Cornell Agronomy Department Paper No. 505.

[2] The authors express their appreciation to Melvin G. Blase and John F. Timmons for having initiated this paper.

[3] Heady, E. O. *Efficiency in Public Soil Conservation Programs,* Prod. Econ. No. 3, Agr. Expt. Sta., Iowa State Coll., Ames, Feb. 1950.

[4] Salter, R. M., Lewis, R. D. and Slipher, S. A. *Our Heritage—the Soil,* Bul. 175, Agr. Ext. Serv., Ohio State Univ., March 1938.

[5] *Reconnaissance Erosion Survey Data,* U.S. Dept. Agr. Soil Erosion Serv., Apr. 16, 1935.

and Eley[6] for the Northeastern United States. These values were not utilized because of the uncertainty surrounding the "minimum permissible rate of erosion."[7] Moreover, only five of the twenty "soil conservation" practices listed could be treated by the Lloyd and Eley equations.

2. This point is well taken. More complete and refined economic factors could not be obtained without visiting the individual farms for the Ontario sample. These economic data were taken from the Soil Conservation district farm plans (see the authors' previous article, page 903). Apparently Blase and Timmons misunderstood the methods used by the authors. We did not "infer" that small (smaller) size of farm causes the adoption of a larger number of conservation practices; we simply stated that with our materials and method this was the case. There may be no "sufficient logical reason why less land in woods is a causal factor in determining the number of conservation practices adopted," yet our low and high groups were different in this respect.

Physical factors have been discussed by the authors elsewhere.[8]

3. The limitations of using non-cooperators' farms have been fully discussed by Fischer and Timmons in reference 8 cited by Blase and Timmons (see page 432 paragraphs 4 and 5). These limitations justify their not being used.

4. A list of practices recommended can be found in the previous article, Table 5, page 908. The complete statements of the practices recommended are contained in the land use or land use capability guides of the soil conservation districts in question. Clearly most of the practices are interchangeable. Social and economic factors make for final decisions within the one soil association under consideration.

5. The authors are in essential agreement with Blase and Timmons on this point, namely: (a) farmers do not have "perfect knowledge" of costs and returns for conservation practices, and (b) this type of educational information is not presented to them because little statistically reliable research concerning costs and returns of conservation practices has been done. Nevertheless, most of the farmers surveyed indicated that if additional money were made available to them they would use some of this money for soil conservation practices. In practice this "additional" money takes the form of incentive payments. Certainly some practices might be profitable enough to make payments unnecessary if this infor-

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[6] Lloyd, C. H. and Eley, G. W., "Graphical Solution of Probable Soil Loss Formula for the Northeastern Region," *J. Soil and Water Cons.*, 7:189-191, Sept. 1952.

[7] Free, G. R., "Effects of Good Management Following Soil Erosion," *Soil Sci. Soc. Amer. Proc.*, 21:453-456, 1957.

[8] Prundeanu, Julian and Zwerman, Paul J., "Certain Characteristics of Land in Relation to Tendency of Farmers to Establish Conservation Practices," Agronomy Jour., 50:438-440, 1958.

mation were made available to farmers. However, most farmers living in the Honeoye-Lima soil association refuse to adopt contour strip cropping or similar erosion control practices even though Free[9] has shown that such practices result in a yield increase of almost 25 per cent. Currently the "incentive payment" is six dollars per acre plus 50 per cent of the cost of removing hedge rows. This cost may be as high as $30-50 per acre.

6. Unfortunately, the "Summary" in the previous article was incorrectly printed. It should have read: "Thus, the high conservation group has *smaller* total acreage, more cropland, *when expressed as percentage of total acreage but less if expressed as actual acreage*, less land in woods, and received higher PMA payments" (corrections in italics).

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[9] Free, G. R., "Investigations of Tillage for Soil and Water Conservation: I. A comparison of Crop Yields for Contour vs Up and Downslope Tillage," *Soil Sci. Soc. Amer. Proc.*, 20:427-429, 1956.

FIXED ASSET VALUATION AND LINEAR PROGRAMMING

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IN A recent paper,[1] Clark Edwards gave an operational definition of a fixed asset, applied the definition to factor markets where the acquisition cost exceeds the salvage value by a finite amount, and traced consequences for the individual and aggregate supply functions. This note supplements that work by showing that when the operation of the farm or other enterprise may be represented by a linear programming model, these factors can be fixed assets, on Edwards' definition, even in the absence of the step in the supply function for the factor. This result follows because, on the linear programming assumptions, the value in use (or marginal revenue product) of the factor is itself a step-function; the implications of this property for farm behaviour in factor markets are also discussed. This step-function property of the value in use has been glossed over in linear programming texts other than those dealing specifically with parametric programming, and has been explicitly denied in one or two instances;[2] hence it seems profitable to give as an appendix, an outline of the derivation of this property, using only geometrical methods.

According to Edwards, "if the cost incurred in changing the quantity used of a given asset is greater than the benefits to be derived therefrom,

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* I am grateful to Mr. A. D. Roy and Professor R. Dorfman for reading and criticising an earlier (algebraic) draft of the material appearing in the appendix.

[1] Clark Edwards, "Resource Fixity and Farm Organization," *J. Farm Econ.*, 41: 747-59, Nov. 1959.

[2] For examples, see Footnotes 7 and 8.

the asset is regarded as fixed."[3] This would appear to admit the orthodox case of intersecting straight-line supply price and marginal revenue product curves. But the case given by Edwards is distinguished by the presence of a step-function. Hence the following re-wording is suggested: *an asset is regarded as fixed if arbitrarily small changes in its supply price or its marginal revenue product or both, give the profit-maximiser no incentive to change the quantity of the stock he holds.*

Thus, in the case described by Edwards, if the value in use p_1 lies between the acquisition cost p_2 and the salvage value p_3 (see Figure 1), any

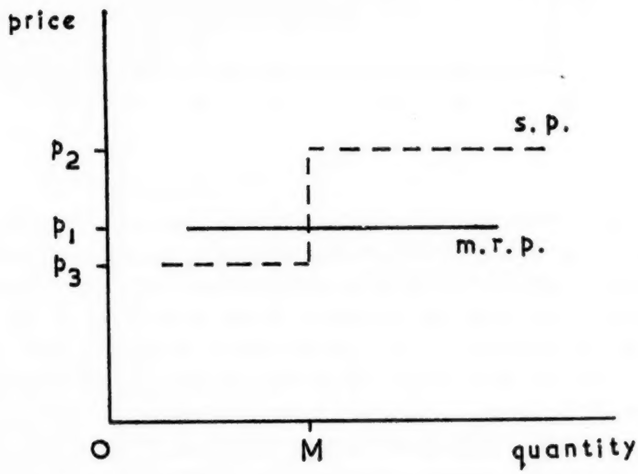

FIG. 1. THE EDWARDS CASE: STEPPED SUPPLY FUNCTION (S. P.), CONTINUOUS MARGINAL REVENUE PRODUCT (M. R. P.)

arbitrarily small changes in these values will not induce the farmer to increase or reduce his initial stock *OM* of the asset, and hence it is fixed. The essential property here is the single step in the supply function *s.p.* The value in use is (implicitly) thought of as being constant, or at the very least, *continuous* in the range of quantities on either side of the initial stock level. If the step in the supply function is absent, then the linear programming case is almost the mirror image of the case shown in Figure 1. To see this, consider the case where the farmer is selling in perfectly competitive markets, and where all factors other than that in question are available only in fixed amounts, or on perfectly competitive factor markets. If the amount of the factor in question is increased, while the amounts of at least some of the other factors are held constant, then the marginal revenue product of the factor describes a descending step-

[3] Edwards, *op. cit.*, p. 749.

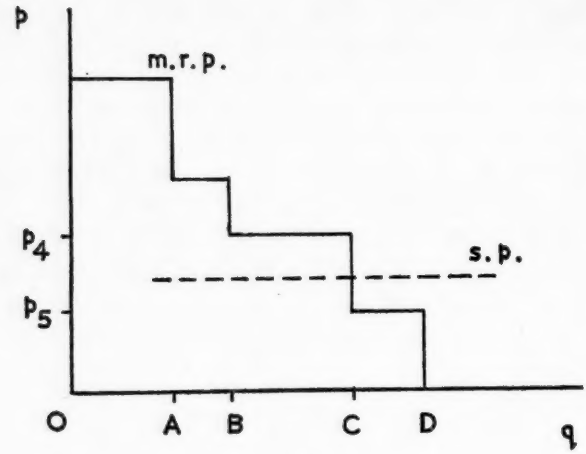

FIG. 2

function such as that shown in Figure 2. In that figure, the heights of each of the steps (e.g. corresponding to the values p_4, p_5, etc.) depend on the prices in the competitive markets for products and for those factors which are not fixed assets. Also, the positions of the steps *A*, *B*, *C* etc. are determined by the amounts of the factors whose stocks are held constant. In Figure 1, on the other hand, the position of the step is determined by the amount of the initial stock of the asset in question.

Now if acquisition cost equals salvage value then the supply function will generally cut the marginal revenue product curve in a vertical segment, as shown in Figure 2. If the supply function has the asymmetry

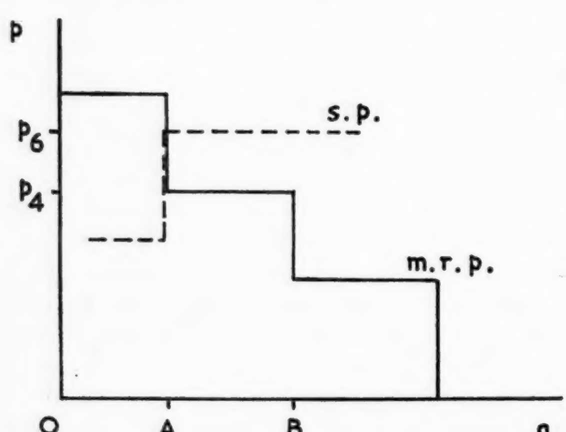

FIG. 3 (a)

described by Edwards, then the two step-functions reinforce each other. Various geometrical cases are possible, and two of these are shown in Figure 3. The individual is assumed to have adjusted his stock in previous periods, in accordance with the profit-maximising principle. Thus in the case shown in Figure 3(a), he will have added to his stock, thereby moving along the horizontal acquisition cost curve corresponding to an acquisition price p_6; in Figure 3(b), he will have diminished it by moving along the horizontal salvage value curve corresponding to price p_7. In either case, the consequent size of the stock corresponds to one of the steps in the marginal revenue product curve; the step in the supply function will then coincide with this step, as shown.

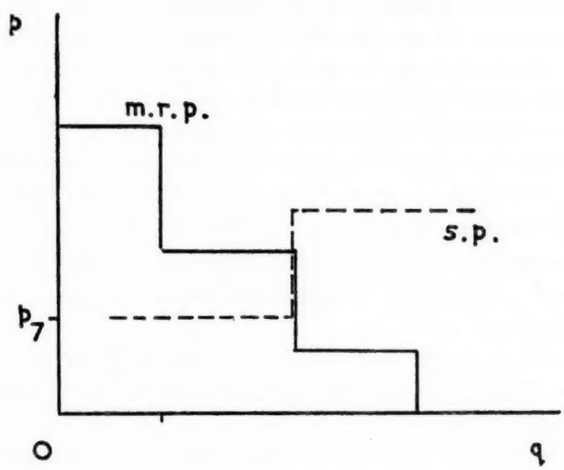

FIG. 3 (b)

Whether or not the acquisition cost equals the salvage value, the effects on market behaviour are broadly the same; also they correspond roughly to the effects on farm organization and supply response noted by Edwards. First consider the individual farm; if, as a result of decisions in previous periods, the enterprise arrives at any of the intersection points shown in Figures 2 and 3, then small changes in any of the factor and product prices which affect the heights of the horizontal sections of the two curves will not cause the profit-maximiser to seek to change his stock of the factor. The asset is fixed, and the demand curve for the factor has discontinuities corresponding to those in the marginal revenue product curve. Consider one case in detail: suppose, in Figure 3(a), that the prices of all other factors and products remain constant, and that the acquisition cost p_6 of the factor is gradually reduced. At first there is no incentive to

change the stock of the asset; but as soon as the price p_6 falls below p_4, the stock should be increased from OA to OB to secure maximum profit. This effect is tempered in the case of the aggregate demand curve[4] since the critical price can be expected to differ from farm to farm because of differences in fixed asset structure.

In many published papers, the linear programming model has been successfully used to analyse farm management operations, suggesting that the assumptions of the model are realistic for this field; hence it seems reasonable to expect that these effects are likely to occur in the markets for some farm inputs.

Appendix

The step-function property of the marginal revenue product curve is here demonstrated in an intuitive manner, which presupposes only an elementary knowledge of the geometry of linear programming.[5] The result is implicit in the published work on parametric programming, where more rigorous algebraic expositions may be found.[6]

For illustrative purposes, the following situation is assumed (see Figure 4): two factors of production, X_1 and X_2, are used to make one product which is sold in a competitive market; the rays P_1, P_2 etc. each represent a different process or technique of production with the two factors combined in fixed proportions; IJ represents an iso-revenue curve, and there is a fixed stock OM of X_1.

If the stock of X_2 corresponds to a point such as E, lying between process rays P_3 and P_4, then the optimal solution will employ these two processes, each at positive levels. For an arbitrarily small movement to *either* side of E, the marginal revenue product of the factor X_2 is the same, being an inverse function of the slope of that iso-revenue curve segment which lies between P_3 and P_4. As E moves upwards, towards B, the level at which P_4 is used decreases and that for P_3 increases, until at the point B the level for P_4 has fallen to zero, only process P_3 is used, and the solution is said to be degenerate. If the stock of X_2 is increased a little more, process P_2 is introduced at a positive level and the level at which P_3 is used begins to decline; thus two processes are used, and the solution is no longer degenerate. The marginal revenue product is constant over the range BC but has a smaller value than before, because the iso-revenue curve has a steeper slope in this segment. Hence the marginal revenue

[4] This corresponds to Edwards' finding on the supply side; cf. Edwards, *op. cit.*, p. 755, footnote 17.

[5] See, for example, R. Dorfman, "Mathematical or Linear Programming: a Nonmathematical Exposition," *Amer. Econ. Rev.*, 1953.

[6] See, for example, S. I. Gass, *Linear Programming* (New York: McGraw-Hill, 1958), ch. 8.

product is constant within each segment, but falls between segments, thus describing a descending step-function of the type shown in Figure 2. (The letters *A, B, C* and *D* correspond to degenerate points in both Figures 2 and 4.) At each degenerate point, there is a discontinuity in the value of the marginal revenue product;[7] in other words, at such points the value depends on the *direction* of change, being greater for a decrease in the supply of X_2 than for an increase. For quantities of X_2 less than *MA*, some of the

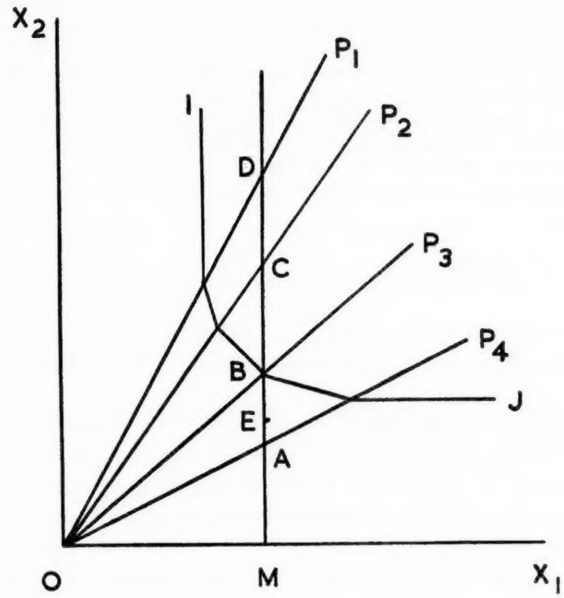

FIG. 4

stock of X_1 is redundant. When the stock of X_2 exceeds *MD*, some of it becomes redundant and the marginal revenue product is zero.

Thus it is seen that the marginal revenue product depends on the set of processes appearing in the optimal solution. At degenerate points, only one process appears at a positive level in the present example, but the simplex method would select also a second process, which would be recorded in the optimal solution at zero level; in the case of the point *B*, this second process would be either P_2 or P_4. If the latter, then the dual value obtained in the simplex method would correctly estimate the marginal revenue product for a decrease in the stock of X_2, but would not be

[7] This has been overlooked in at least one text; see R. Dorfman, P. A. Samuelson, and R. M. Solow, *Linear Programming and Economic Analysis* (New York: McGraw-Hill, 1958), p. 166, footnote, where it is claimed that there is only one discontinuity, namely where the asset is "just on the border line of being redundant."

relevant for the valuation of an increase. If the former, then the opposite holds.[8]

The discontinuities in the marginal revenue product described here for a special case, are present also in the general case when the asset in question is used with any number of other factors to produce any number of products.

[8] Again this point is commonly overlooked, and in some texts giving numerical examples, mistaken valuations are given. In the present two-dimensional example, any dual value found must be relevant for either an increase or a decrease in the stock of the factor. But in cases having more than two dimensions, one can find dual values which correspond to sets of process vectors which are not relevant for either change, and which imply infeasible solutions. For an example, see A. Charnes, W. W. Cooper and A. Henderson, *An Introduction to Linear Programming* (New York: Wiley, 1953); here the primal nut-mix problem has a degenerate solution, and on p. 10 the dual value given for W_{13} does not, in fact, measure the marginal revenue product for either type of change.

INTEGRATION AND GAME THEORY

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IN HIS recent article,[1] Trifon outlines a comprehensive set of hypotheses relative to the integration of agriculture with industry. To complete the picture, it is perhaps worth noting that the phenomena of integration and contracting, and cooperatives too, might be fruitfully analysed within a game theoretic framework.

For instance, these phenomena can be viewed as coalitions in the *n*-person game being played by farmers, processors, retailers and consumers. Certainly, given the existence of such a concatenation of entrepreneurs whose decisions interact, we would expect to find coalitions of one type or another, even though and perhaps because the von Neumann-Morgenstern assumption of full information has to be ditched.

Such an approach leads directly to the problems at the heart of integration. To wit: How viable are these coalitions? What are their effects on those in them? On those outside them? Are there better ways of playing the game? To some extent, at least normatively, these questions flounder on the fact that an ideal solution to the *n*-person game is unavailable. Still, this is but further reason for studying integration within a game theoretic framework. Not only may integration be one of the empirically feasible solutions to the game, it is also a solution we can watch through its formative stages.

[1] Raphael Trifon, "Guides for Speculation about the Vertical Integration of Agriculture with Allied Industries," *J. Farm Econ.*, 41:734-746, Nov. 1959.

COLLINS' CHANGING ROLE OF PRICE*

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THE *changing*[1] or *declining* role? After the third trip through this brief article, I deduce the latter. Following the first perusal, I had the fortune to confer with the author in a setting not too conducive to clarification of such ideas, but at which time it was indicated that a word change in the title may increase its harmony with the text.

Perhaps the most legitimate question relative to Collins' narrative is that in dramatic fashion he has told us what role price has changed *from*, but has not so clearly told us what it has changed *to*. Put another way, he has discovered a vacuum (I cannot judge whether or not this was intentional) which exists in the realm of vertical integration with respect to the pricing mechanism in agricultural markets. This modest note first asks a question about the word *changing*, then digresses for a bit of exploration and suggestion on its own.

Three quotations from Collins' article are given as evidence that the title of the original article could be a misnomer:

> 1. The question suggested by these developments is: Why do firms choose to use such administrative arrangements *rather than* to rely upon the open market where price provides the main coordinating mechanism?[2]

The author is discussing those arrangements whereby an integrated conglomerate of firms may agree jointly to decisions affecting their income positions in the production-marketing hierarchy. In using the term "rather than" in the context quoted above it appears that he is relegating price to an inferior role in market coordination, which would be a declining role as compared to its former performance.

> 2. Yet, the increased demand for an improved communication network and for a better coordinating mechanism has seemingly far outdistanced the capabilities of a system based primarily on prices.[3]

This is a statement buttressing the affirmation that price is incapable of conveying the message generated by all forces in the market. It is evident to most of us that, despite advances in reporting, communication, and product grading and standardization, there are certain offsetting tendencies toward heterogeneity in consumer tastes and product differentiation

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* Collins, Norman R., "Changing Role of Price in Agricultural Marketing," *J. of Farm Econ.*, 41:528-34, Aug. 1959.

[1] All italics are mine.

[2] Collins, *op. cit.*, p. 530.

[3] *Ibid.*, p. 532.

which have been instrumental in forcing price into a secondary role in market coordination for many agricultural products. There seems little question but that this is a declining role in the sense of its former function.

3. *Instead of* translating the technical conditions facing the retail operation into a price message which is then relayed to and interpreted by supplier firms, conversations are held directly in terms of actions to be taken or in terms of the desired product specifications.[4]

This wording almost leaves us with the impression that the price system is not only being outperformed by an alternative procedure of communication, but that it is being replaced all along the line. It is a fact, as Collins reports, that decisions about production often must be made well in advance of any exchange transaction and price determination. Also, in many instances any past price relationships may be misleading in agricultural production planning. Conclusion: price is relatively less important in this role.

My point of conjecture is that the article in question plus several other pieces of literature on the subject of vertical integration[5] have delineated the declining traditional role of price in open agricultural markets, but have only hinted at any new role. Moreover, a very legitimate objection can be raised to such a partial treatment of the role of price in agriculture. Collins' argument contains several elements of truth, but it proceeds from a rather narrow range of observation. In short, it is rather dangerous to treat the changing role of prices in agricultural marketing without taking into consideration the *total* role of prices in the organization of resources in an enterprise system.

Collins in his last paragraph finally says: "Yet, price determination is of crucial importance in these dealings, being basic to the allocation of income between the parties and allocation of resources among alternative uses."[6] I more than agree, in other words, with the rather obvious observation that open market operations are on the decline and that a price system to convey all product attributes in a fast-moving marketing system is too expensive and well nigh impossible. But what is there to say beyond this?

The traditional role of prices in agriculture has involved four fairly distinct functions:[7] (1) to guide the allocation of resources in production, (2) to channel products into the market, (3) to distribute income from

[4] *Ibid.*, p. 533.

[5] For example see: Mehren, George L., "How is the Market Made in Integrated Industries?" *Proceedings,* Eighth Natl. Inst. of Animal Agriculture, Purdue Univ., April 1958, pp. 52-69.

[6] Collins, *op. cit.*, p. 534.

[7] Adapted from Schultz, T. W., *Production and Welfare in Agriculture,* p. 72.

farming over time, and (4) to allocate income among persons and firms in the distribution process. It is my contention that while function No. 2 has declined in its relative importance as a regulator of the market mechanism, functions No. 3 and No. 4, but particularly the latter, have come to the fore. If this is what is meant by the changing role of price (I am not so sure that Collins does mean this) let us then in our research discover something about the new role. In essence, we then enter the sphere of welfare economics; i.e., by enhancing marketing efficiency through the elimination of inefficient coordination we make it possible to increase the level of incomes of all parties involved in the distribution negotiation. Who gets what part of this increase, or who should get what part, is not a new problem for marketing researchers, but it is one which has not been central in our thinking in recent years. Resource allocation—function No. 1—can no doubt be improved by a system of determined prices and administrative arrangements which guide production practices. The role of price theoretically has not changed in this sphere, but much research is still needed there.

It is worth noting that many of us who are in general accord with Collins' limited treatment may be underestimating the possibilities already present for agricultural market coordination. This we may be doing because we underestimate the instantaneity and the character of current price communication, and because we play down the role of the commodity exchanges in price formation. Furthermore, some of our thinking may be colored by a constant dealing with agricultural perishables.

A particular conclusion is evident from this note: more research is needed on the current role of price in agricultural marketing. As one example, when Professor Mehren tells us that price competition is brutal[8] among large retailers, an hypothesis must be set forth to this effect and proved in a general scientific sense sufficient to satisfy our professional intuition. How brutal is price competition among large retailers in a merchandising world where both product and service differentiation are on the increase? When retailers push their own labels, when the average shelf exposure for national brands is declining, and as local locational monopoly increases among supermarkets, just how brutal is price competition? How intensive can this brutality become in a system where market price for agricultural products, being a variable which is simultaneously determined by large interfirm conglomerates, has a limited variability, and where retail margins are narrow and are narrowing?

Finally, perhaps just as important as research, and maybe more difficult

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[8] Mehren, George L., "The Changing Structure of the Food Market," *J. Farm Econ.*, 39:347, May 1957.

of our attainment, is the necessity for a prudent attitude toward the price system. The price system has many inadequacies. We are aware of this, and it has been vividly demonstrated by Collins and others. Prices in agricultural markets, however, are not fixed by fate or conspiracy to reward or punish individual producers of products and services. I would offer the following as a point of departure for our thinking on the role of prices in agriculture: Insofar as prices are regarded as indicating opportunities to maximize income through resource reallocation, the emphasis should be placed not on price relationships as such, but on the capacity of production and marketing firms to reallocate. And, insofar as prices are regarded as a tool to proportion incomes between and among farmers and between farmers and the rest of the economy, the emphasis should be placed not on the proportioning function as such, but on the capacity of prices to assist in raising the levels of incomes for all.

COLLINS' CHANGING ROLE OF PRICE—A REPLY

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University of California

A READING of Professor Hillman's comment convinces me that it is its own best answer. The issue raised is whether it is more appropriate to use the word "changing" in describing the role of price or whether we might better say "declining." To refresh our memories on the main point of the original article, it was argued that the incentive for certain important changes in the agricultural marketing system, those represented by various forms of incomplete vertical integration, may be the desire to improve coordination among firms engaged in one or more of the interrelated food production and distribution activities.

The word "changing" was used in the title to refer to the general role of price in the agricultural marketing system. If I had used the word "increasing," I could understand Professor Hillman's objection, but there is nothing in the choice of the word "changing" that precludes the possibility that the change is in the negative direction, i.e., a decline. However the decline, if any, is in one of the many functions of price, viz., the *coordinating function,* since it is true that a variety of administrative devices have been established with one of their main purposes being to assist in improving interfirm coordination. It was not argued, of course, that this is the only purpose of integrated arrangements, that the role of price is completely supplanted even in this regard, nor that price has no other useful functions. I would not quarrel strenuously with the use of the

word "declining" if it were made evident that we are talking about the role of price for the purpose of interfirm coordination for a particular set of industries. But one would really evidence a penchant for hairsplitting to carry such discussion too far.

Since I did not undertake to write a treatise on all aspects of prices or even agricultural prices, there was no call to make a summary statement as to whether the over-all role of prices had declined. Indeed, I suspect that such a conclusion would be without much meaning. Professor Hillman suggests it is dangerous to discuss the coordinating role of price "without taking into consideration the *total* role of prices in the organization of resources in the enterprise system." I would certainly agree to this danger if it were true that it was our purpose to conclude on the basis of an analysis of one function of price that the usefulness of prices in general had become less. But the point is that this was not done. It is both reasonable and useful to consider separately the various roles prices play in our economic system. This I attempted to do regarding certain problems that the agricultural marketing system faces with respect to interfirm coordination.

Further discussion and study of the role of price are needed, as Professor Hillman suggests. The coordinating role of futures prices, for example, was not considered. Another matter that bears study is the coordinating role price can be expected to play in industries with different market structures. Concentration ratios, degree of inequality of large compared with small firms, and the turnover among the largest firms vary significantly from one food industry to another.

PRODUCERS' QUASI-SUPPLY DURING STOCK PERIOD—A COMMENT

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IN THE February 1959 issue of this *Journal* Professor Pesek reminds us that:

> Supply and demand are such well-developed tools of economic analysis that they are more likely to be subjected to minute refinements than to major innovations. When such innovations occur, they deserve careful scrutiny before being permitted to enter the body of economic theory.[1]

This unexceptionable statement is followed by an examination of "one

[1] Boris P. Pesek, "Producers' Quasi-Supply During Stock Period," *J. Farm Econ.*, 41:103.

such innovation . . . presented by T. W. Schultz in his book on *The Economic Organization of Agriculture.*"[2] Pesek presents a "corrected" version of Schultz' "innovation" and concludes that it is a basic departure from the Marshallian concept of supply.

I suggest (1) that Professor Pesek is mistaken when he attributes an innovation to Professor Schultz, (2) that his scrutiny of Schultz' "new concept" contains an analytical error, and (3) that the ambiguity which develops in his "correction" of Schultz' work is more apparent than real.

1. The "new concept," as identified by Professor Pesek, is presented in the words of Professor Schultz:

> It is necessary, especially in agriculture, to distinguish among three types of producer supply. We have the two supply concepts usually employed in economic analysis, namely, the supply in the long and in the short run, to which we shall add the concept of the supply of producers during the stock period, which represents the time interval during which neither variable nor "fixed" costs in production are relevant to the supply of producers. It is the period during which the stock under the control of producers is given by the harvest and the carry-over of producers.[3]

Economists cannot fail but note the striking similarity between the "stock period," thus defined, and Marshall's familiar "market period."[4] Surely the concept of a "stock" period is not new; if there is innovation here, it must be found in the nature of the supply function which exists in the Stock Period. Later in his paper Pesek does show that, in a market in which sellers' self-use is important, the producers' supply is partly a function of the elasticity of consumer demand. This interdependence will be discussed below. Unfortunately, however, the development of Pesek's argument is marred by a rather serious analytical error.

2. Pesek examines the "stock period" supply function of an individual producer under specified assumptions, the most important of which are that expectations are ruled out and that the producer is, himself, a consumer of a significant portion of his own output. The argument is presented with the aid of Diagram I, and is as follows:

An individual consumer has an income of OY_1, faces the price line Y_1A, and would consume OC of the commodity in question. At the alternatively higher price Y_1B, the individual consumer would consume only OD. The decline in consumption is due to the combination of CE substitution effect and ED income effect.[5] Pesek then observes the be-

[2] Macmillan, 1953.

[3] Schultz, op. cit., p. 232.

[4] See Marshall, *Principles of Economics*, 8th ed., Bk V, chs. 2 and 5. Among the numerous textbook treatments of the Market Period see Stigler, *Theory of Price*, Macmillan, 1946, pp. 148-153, or Samuelson, *Economics*, 4th ed., McGraw-Hill, 1958, p. 382 ff.

[5] Pesek, pp. 105-106.

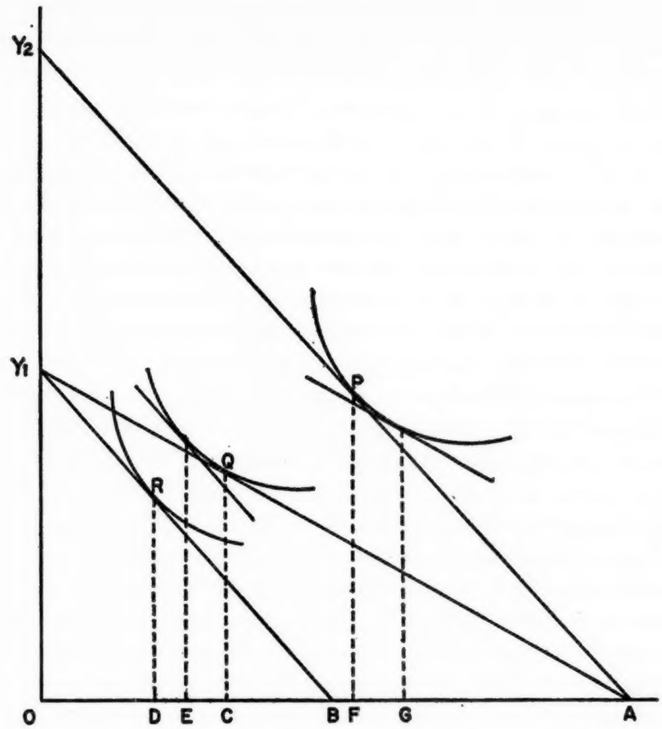

DIAGRAM I

havior of an individual producer who "enters the analysis with the quantity OA and (given the original price) the ability to realize OY_1 income." Considering a price change as before, the price line becomes AY_2 and the individual will consume the quantity OF. Contrasting this rate of consumption with that of the consumer above (OD), Pesek concludes that a (producer) "received income" effect of DF more than offsets the combined (consumer) income and substitution effects. Considering *all three* effects, the price increase leads the individual producer-consumer to consume more and to offer less in the open market. Generalizing, Pesek concludes that the shape of the individual's supply function depends upon the extent to which the (producer) "received-income" effect offsets the (consumer) income and the (consumer) substitution effects. The extent of the offset would depend upon whether the product under consideration is an inferior or superior good and, of course, would vary between individuals.

I believe that this analysis is faulty and, therefore, the conclusion erroneous. By combining the separate analysis of the consumer- and

producer-type behavior, Pesek has unwittingly introduced an autonomous, exogenous change in income. Using price line Y_1A, we can express (measure) the individual's income as either OA of the commodity or OY_1 of money (other things). *If* this individual held a stock of money OY_1 and if the money price of the commodity increased, the individual's income in terms of the commodity has unequivocally *fallen*. *If*, however, the individual held a stock OA of the commodity, an increase in the price of the commodity means that the individual's income in terms of money has *increased*. By combining the two situations, we have the absurdity of a given price change at once increasing and decreasing income.[6]

In technical terms, Pesek has measured the consumer's income, the income effect, and the substitution effect in terms of money; he has measured the producer's income and the "received-income" effect in terms of the commodity. The shift of a single individual's market possibilities from AY_2 to BY_1 clearly implies an increase in real income, whether measured in terms of money or the commodity, which must be independent of any change in relative prices. It is impossible, by changing relative prices, to move from one of these two lines to the other. In short, Pesek has implicitly introduced an exogeneous change in income.

I believe that Pesek is, at this point, concerned with explaining the *shape* of the individual producer's supply function. If so, the standard existing analysis is quite adequate for the job. Referring again to Diagram I, given a stock of the commodity OA and given the market possibilities AY_1 our individual's equilibrium position is at point Q wherein he sells AC and retains OC for self-use. At the alternatively higher price AY_2, he would reduce his sales to AF, the net result of CG income effect and GF substitution effect. In the new market situation the amount demanded for self-use has increased from OC to OF. The income effect of the price change *is* included; the effect upon the individual's own demand *is* shown.

Moreover, this situation is not such a "unique" or "special" case. After all, the majority of individuals are suppliers as well as consumers of what they supply, whether in rich, highly-developed economies or in poor, under-developed, agrarian economies. *Any* worker is in precisely this position. He sells a significant portion, but not all, of his leisure (labor) time. If the wage rate were to rise to a new higher level he would offer more or less labor service in the market place, depending upon whether or not the income effect is large enough to swamp the substitution effect of the change in wage rate. Since leisure cannot be considered an inferior

[6] Since we operate in the stock period, the term "wealth" might be more appropriate—and illuminating—than "income."

good, less work and more leisure (or do-it-yourself projects) is a commonplace possibility. The standard existing analysis of the individual seller indicates that the income effect normally offsets, at least to some extent, the substitution effect of a price change, thus explaining very steep or even backward-sloping supply curves.[7]

Parenthetically, we may observe that a producer-consumer who has already achieved his optimum adjustment at Q will, in response to a subsequent price change, re-enter the market place. Diagrammatically, a price change will rotate the price line at Q so that it intersects the indifference curve. A price increase will induce further sales (and less self-use), a price decrease will induce repurchase. Under these circumstances, the supply-demand function of the individual always has "normal" properties, even if the commodity is an inferior good.

If the foregoing criticism is correct, Pesek's concept of a "received-income" effect is inadmissable. However, the concept is superfluous—it is not crucial for his subsequent discussion.

3. In the final sections of his paper, Pesek presents an analysis showing that the position of an individual's supply function is a function of the public's demand, i.e., that the market supply and demand schedules are not independent.[8] He concludes that it is impossible to derive an unambiguous supply schedule under these circumstances. To establish the existence of a functional relationship between the demand schedule and the supply schedule is a significant contribution. It is too much, however, to claim a new concept of supply. Moreover, I believe that the alleged ambiguity proceeds from Pesek's analytical structure and not from the market structure postulated.

The Marshallian supply (and demand) functions, which are Pesek's point of departure, assume constant tastes, prices of related goods, and incomes. However, the "income effect" of a change in relative price raises questions about the income assumption. This is especially important on the supply side of the market since sales are likely to be the major or only source of income for any individual supplier of a particular commodity, i.e., the income effect will normally be large.

Pesek isolates the income effect of a change in relative price and derives a supply function based upon an assumption of constant real (psychic?) income.[9] His (quasi) supply function shows alternative amounts offered

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[7] Cf. T. Scitovsky, *Welfare and Competition*, Irwin, 1952, pp. 88-92.

[8] Pesek, pp. 107-110.

[9] It is my impression that income is here defined in a "level of welfare" sense. That is, a constant income would be represented by points or combinations of goods along a single indifference curve.

at alternative prices on the assumption that there is no income effect of a change in relative prices. Since there really *is* an income effect, there is a different (quasi) supply function for each of the several prices. Thus, Pesek concludes that each shift in the consumer demand, since it leads to a price change and to a change in suppliers' real income, causes a shift in the supply function.

On procedural grounds there can be no objection to this analysis. A (quasi) supply function which reflects only the substitution effect permits an additional insight into the nature of the supply function. It can then be shown that, to a very limited extent, the supply function is determined in a systematic way. But this procedure clearly introduces an ambiguity, or at least a cumbersomeness, since a change in relative price requires both a movement along the supply function and a movement of the function. However, a change in relative price *does* have both an income and a substitution effect which may be reflected in a single unambiguous supply function.

Referring again to Diagram I, we may connect points *A*, *Q*, and *P*, deriving a price-offer curve which subsumes both the income and substitution effects of a change in relative price. From the price-offer curve we can construct a single, unambiguous supply function. Assumed constant are tastes, prices of other goods, and income measured in terms of the commodity (*OA*). The income effect of the price change is measured in terms of money or other things, and is reflected in the amount of the product retained for self-use. If we choose a numeraire—in this case the commodity traded—and stick to it, there is no ambiguity.[10] This usual procedure, in contrast to Pesek's, is equally rigorous, equally good in predictive power, at least as realistic, and less cumbersome.[11]

In short, the multiplicity of quasi supply functions is a consequence of Pesek's treatment of the income effect of relative price changes as if it were an independent phenomenon. The ambiguity lies in Pesek's *quasi* supply function, not in the *market* supply function. While it is true that the supply function's shape will reflect, to a very limited extent, the elasticity of the demand function—and this is an interesting point—we can still ascertain that, for any given market with a given demand schedule, there is a unique and determinate supply function as well as a unique and determinate price.

[10] There are problems here—problems of representing the gain from trade, the use of Consumers' Surplus, interpersonal comparisons—problems which are avoided in Marshallian analysis by an assumption of constant marginal utility of money. (See B. F. Haley, "Value and Distribution," *Survey of Contemporary Economics*, H. S. Ellis, ed., Philadelphia, Blakiston, 1948, Chap. I, p. 5.) I take it that these are not problems of concern in the present context.

[11] Cf. Pesek, p. 112.

PRODUCERS' QUASI-SUPPLY DURING STOCK PERIOD–REPLY

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PROF. CHILD'S comment on my recent paper is in two parts: (1) An attempt at detailed destruction of my analysis of the producer's response to a change in price of a commodity of which he possesses a stock; (2) a less severe criticism of my subsequent development of the producer's quasi-supply function.[1]

It appears to me that our differences arise basically out of Child's failure to understand the problem with which I was attempting to deal, and his consequent objection that I had failed to solve a *different* problem that *he* has in mind. This issue I shall attempt to clarify.

Child's failure to understand my problem or my solution of it can be best demonstrated by a restatement of his description of my solution. He writes:

> Pesek isolates the income effect of a change in relative price and derives a supply function based upon an assumption of constant real (psychic?) income. His (quasi) supply function shows alternative amounts offered at alternative prices on the assumption that there is no income effect of a change in relative prices. Since there really *is* an income effect, there is a different (quasi) supply function for each of the several prices.

But the supply function SS in my Figure 2 could not be constructed without the revenue curve *RR* situated in the lower right-hand corner of the graph. This revenue curve shows the changing income of the farmers (given my simplifying assumption of no cost of production). Because prices of all the commodities purchased by the farmer with this income are constant, real value of these receipts is equal to their money value. Thus changing real income is an integral part of my analysis and underlies explicitly, both in the text and in Figure 2, my construction of the supply schedule. Constant income, real or psychic, is definitely not assumed. The response of the farmers to this changing real received income is shown in the lower left-hand corner of Figure 2 by the *EE* curves. Thus income effect is an integral part of my analysis and underlies explicitly, both in the text and in Figure 2, my construction of the supply schedule. Absence of the income effect is not assumed. Finally, there is

[1] Professor Child also objects to my borrowing Professor Schultz's term "stock period," to which he prefers "Marshall's familiar 'Market period.'" Unfortunately, I am unable to find the term "market period" in the chapters of Marshall to which he refers me. But quite apart from this, I consider "stock period" preferable for present purposes anyway. It draws attention to production conditions (e.g., annual harvest); "market period" points rather to marketing rigidities (e.g., Patinkin's weekly fair).

one (quasi) supply function for various prices (and various incomes). Child's entire discussion is based on this misunderstanding of my solution and is vitiated by it.

Finally, throughout the text, Child asserts that my solution is "ambiguous"— apparently because it involves "a multiplicity of supply functions." Actually, in my solution each demand function has its own supply function; their intersection then yields a unique and determinate price. This is not as unusual as Child feels it is and certainly does not merit the charge of ambiguity. In many macroeconomic models we find cases in which each aggregate supply has its own aggregate demand.[2] As in my model (which is actually a very simple two-sector macroeconomic model) a shift of one function leads to a determinate shift of the other.

Reconciliation of the Two Solutions

The reason for Child's failure to understand my solution seems to be his firm commitment to his own problem and his own solution of *that* problem. Because of it, he cannot see another, similar, problem and a solution of it except in terms of erroneous deviations from his own.

Actually, the crucial difference between us can be found in our definition of farmers' income. He wants farmers' income "measured in terms of the commodity" and equal to the stock of it: *OA* in his Figure 1. I define this income to be the real value of the receipts of the farmer from the sale of his commodity. The price index used to deflate this income is based on the prices of the commodities the farmer buys with this income. Therefore the income is measured in terms of all the other commodities. I make the behavior of my farmers depend on income as I define it (curve *RR* in my Figure 2);[3] Child makes the behavior of his farmers depend on income as he defines it (quantity *OA* in his Figure 1).[4]

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[2] Cf., e.g., Sidney Weintraub, "A Macroeconomic Theory of Wages," *Am. Econ. Rev.*, 46:835-856, Dec. 1956, and especially p. 851; or L. E. Gallaway, "The Wage-Push Inflation Thesis, 1950-1957," *Am. Econ. Rev.*, 48:970, Dec. 1958.

[3] My *EE* curves, showing the response of the farmer to changing income, are constructed so as to "show the relationship between the *received* incomes [emphasis added] and the retained quantities of commodity C" (p. 109). The revenue curve *RR* (called *RR* precisely to remind the reader that it represents income received) shows simply the products of quantities sold and prices charged. It enables me, in Fig. 2, to select an appropriate point on one of the *EE* curves. While on the whole any author has only himself to blame if he is misunderstood, in this case I hesitate to shoulder the blame: my article contains clear definitions of all the concepts I use.

[4] This difference between our respective definitions explains why one of the key points in Child's discussion is his attempt to show that "Pesek has unwittingly introduced an autonomous, exogenous change in income." Any change in income as Child defines it (and as he thinks I define it) *would* be exogenous: the stock of the commodity is assumed by both of us to be given. Any 'received income effect' based on such an illegitimate change in income would not be permissible.

Income as I define it does change, purely endogenously, with relative prices. The

In both my solution and Child's the supply function is obtained by a simple subtraction of the farmer's demand for his own commodity from the given stock. The Marshallian demand function requires that the income determining the behavior of the demanders be constant. By defining this income to mean the stock of the commodity, Child has no problem with keeping it constant: it is constant by definition. Thus he obtains a single (Marshallian) demand function and, after subtraction, a single supply function. Since I define farmers' income to mean the real value of the receipts obtained from the sale of the farm commodity, I have no way of keeping *this* income constant. Thus I can only obtain *a set* of (non-Marshallian) demand functions and, after subtraction, *a set* of supply functions.

Child believes my "ambiguity" would be remedied if I would only "choose a numeraire—in this case the commodity traded—and stick to it." But then I would have to accept simultaneously Child's definition of income and Child's assumptions about the force which determines the behavior of the farmer. I would simply give up my problem and start solving his. Obviously, no mere numeraire can bridge this basic difference between our two models.

Conclusion

Child claims that his solution is "equally rigorous, equally good in predictive power, at least as realistic, and less cumbersome"; that it is less "ambiguous"; that it shows what Child considers to be the contribution of my paper, namely that the "supply function's shape will reflect, to a very limited extent, the elasticity of the demand function."

On the basis of my reconciliation of our two models I would like to endorse the claim of equal analytical rigor and to make a claim of equal lack of ambiguity. I would deny, however, that Child's supply function reflects to *any* extent the elasticity of the demand of the public. In contrast to mine, Child's supply function is completely independent of this demand and could exist (as mine could not) in complete absence of it.

Cumbersomeness of the two solutions cannot be compared: a more complex problem is likely to require more complex analytical tools.

I reject Child's *ex catedra* claim of equal predictive power. Only empirical evidence can resolve the issue whether the behavior of the farmer depends on income defined as the physical quantities of the farm commodity produced or on income defined as the real value of the receipts from the sale of these farm commodities.

The question of greater realism I would prefer to leave unanswered be-

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received income effect based on such a definition is, of course, not only permissible but measurable as well.

cause I am convinced that realism of assumptions is irrelevant and predictive power the only valid criterion for a choice among competing models. If pressed on this point, however, I would suggest that it appears to me less realistic to make farmers' behavior depend on income defined as the physical quantity of their stock. Conversely, it appears to me more realistic to make farmers' behavior depend on income defined as the real value of the receipts realized from the sale of some part of their stock. An example might drive this point home: even with an *inelastic demand* for a farm commodity, a harvest failure will nevertheless be classified as a decline in farm incomes under Child's definition. It will be classified as an increase in farm incomes under my definition.

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ALLIED SOCIAL SCIENCE ASSOCIATIONS
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THE FARM POLICY DEBATE: THE ADMINISTRATION'S POSITION AND AN INDEPENDENT VIEW

CHAIRMAN: GEORGE E. BRANDOW, PENNSYLVANIA STATE UNIVERSITY

IN SUPPORT OF THE ADMINISTRATION'S FARM POLICY

DON PAARLBERG
Special Assistant to the President

IN THIS address I wish to make four points:

1. The farm price-support and production-control legislation now on the statute books does *not* represent the Administration's farm policy.
2. The farm policies which this Administration *does* support include many activities other than price support and production control.
3. On the controversial price-support and production-control issue, the needed modifications lie, as embodied in the Administration's farm proposals, in the direction of greater opportunity for individual persons to exercise their judgment as to what should be produced and at what price it should be sold.
4. The alternatives to the Administration's farm policy are generally lacking in promise.

I now shall take up these points individually.

I

First, let me trace the origin of the farm price-support and production-control legislation we now have, legislation which is generally considered to be unsatisfactory.

In making the flat statement that this legislation is considered unsatisfactory, I wish to acknowledge the good record of the Congress as regards price support and production policy for the majority of our farm products; that is, for commodities other than the so-called basic crops. I want to make clear my view that legislation providing for marketing agreements and orders has generally been helpful, as has legislation authorizing the purchase of surplus farm products and their diversion to the school lunch program and to needy persons. What I am speaking of as unsatisfactory is the mandatory system which requires price support for a few favored commodities at artificially high prices, and couples that support with a half-hearted and ineffective control effort. This is the system which has failed.

I have come to harbor misgivings both with respect to those economists who think they can analyze farm problems without reference to politics,

and those politicians who think they can solve farm problems without reference to economics.

The basic legislation with respect to farm price supports and production control was enacted in 1933. This was done in an effort to meet the grave problems of a world-wide depression.

This legislation was clarified and modified in 1938. The major intent of the 1938 Act was to give continuing status to the emergency legislation of 1933.

In 1941 and 1942 the Steagall Amendment and other legislation were passed. Price supports were raised to a high level during the war emergency and their continuation was assured for two years after the war.

In 1948, Congress provided for an adjustment from the war-time level of price supports, but this law was not allowed to go into effect. The next Congress rewrote this law and delayed the date at which it was to become operative, thereby continuing the war-time price-support levels.

In 1952, Congress further extended the war-time level of price supports.

In 1954, Congress allowed the 1952 extension to expire, thereby permitting the functioning of legislation previously enacted.

For the five years since the Congressional elections of 1954, the Congress has been controlled by one party and the Executive Branch by another. During this period some helpful modifications of the price-support and production-control legislation were enacted, but legislation for most of the so-called basic commodities remains generally similar to the pattern of earlier years.

During twenty-two of the twenty-six years encompassed by this legislative history, the Congress was controlled by the party now in the majority. The party now in the minority held Congressional responsibility during 1947-48 and again during 1953-54. During the first of these two periods, farm legislation was enacted which a succeeding Congress kept from becoming effective; during the second period legislation was passed which allowed a law enacted by a previous Congress to become operative.

Thus practically all present farm legislation regarding price supports and production controls were written by the party now in the majority. Continued existence of this legislation is tolerated and condoned by the majority party, which has the power to change it.

It is sometimes said that the present Congress cannot enact farm legislation because of the threat of veto exercised by the Executive Branch. However, no truly remedial legislation has been vetoed, or is likely to be.

It is frequently said that farm policy has been bi-partisan. But the effort to place responsibility upon this Administration for the shortcomings of farm legislation is certainly a partisan effort, and an unwarranted one.

With respect to farm legislation, the Executive Branch has two re-

sponsibilities. One of these is to administer laws enacted by the Congress. This the present Administration has done, and done faithfully. The other responsibility is to recommend legislative changes for the Congress to consider. This the present Administration has also done. For seven years now the Administration has been invited by the Congress to make recommendations for improving our farm legislation, and has complied faithfully with these requests.

Some of the Administration's recommendations have been heeded. Public Law 480, the basic authority for surplus disposal, was enacted much as recommended. The same is true of the Rural Development Program.

Others of the Administration's recommendations were accepted in part, though considerably modified. This was true of the Soil Bank and the present corn program.

Most of the Administration's recommendations have been resisted by the Congress, particularly those having to do with price support levels and production-control policies.

The Administration cannot possibly be responsible for legislation which antedated its period of service and emanated from another Party.

Existing difficulties with the farm program, and they are many, cannot possibly be the result of legislation which the Administration has recommended if such legislation has not been enacted.

Congress cannot divest itself of legislative responsibility. Nor can the Executive Branch divest itself of its administrative responsibility. Surely the Congress will not accept responsibility for errors of the Executive Branch in administering our farm laws; nor can the Congress expect the Executive Branch to accept responsibility for legislative shortcomings.

Almost nobody defends the farm legislation now on the books. The pertinent point is that this legislation was put there by the Congress. If it is to be changed, it must be changed by the Congress.

Present farm legislation does not represent the policies of this Administration, as I have endeavored to show. On the contrary, it must represent the farm policies of the majority party, since that party put it on the books and left it there despite having the power to change it.

There is a studied effort to create the illusion that the failure of agricultural adjustment policies is an administrative failure while in reality it is clearly a legislative failure.

If there is a failure to administer our farm laws as enacted by the Congress, this is a matter properly to be laid at the door of the Administration, but I do not know of any serious charge of this kind. If there is a failure of the laws themselves, which is the fact, this is a responsibility of the Congress.

There exists a great confusion in the public mind as to the separate responsibilities of the Executive and the Legislative Branches of Government. Some members of the Congress have heightened and exploited this confusion, rather than address themselves to their proper task, which is the writing of needed legislation.

II

Having attempted to make clear the fact that present legislation does *not* represent the Administration's farm program, I shall now indicate what actually constitutes the Administration's farm program. There is support for activities in eight different areas; there are recommended changes in one.

First, there are the historic services that concern the development of human resources, among them education, research, and the supplying of needed information.

Second, I name the Rural Development Program, by means of which we endeavor to open wider the doors of opportunity for the million and a half rural families with very low incomes.

Third, I would name the development of natural resources and their intelligent use, including the Conservation Reserve, various land-use programs, the activities of the Forest Service and related matters.

Fourth, is market-building, which relates to consumer education at home, market development abroad, and research to discover new uses.

Fifth, I shall list surplus disposal, those activities which move into use, through special programs, our heavy government stocks of farm products.

Sixth, are the credit programs, intended to meet a variety of needs, written for varying periods of time.

Seventh, there are regulatory activities to insure the wholesomeness of the food supply, the proper functioning of the commodity exchanges and similar activities.

Eighth, there are the marketing orders and agreements, the purchase and diversion of surplus products to the school lunch program, and the authority to support prices of the great majority of farm products at levels discretionary with the Secretary of Agriculture.

Ninth, for the problem crops, particularly wheat, legislative changes are proposed which move in the direction of greater freedom to plant and less interference with market forces.

Some of these activities were launched by this Administration. Others originated earlier. All have Administration support. It is clear that the Administration's farm program is a broad one, encompassing many areas of service rather than one.

There is general agreement on the appropriateness of the first eight of

the services I have listed. Despite occasional friction regarding one or another, they have been the cause of relatively little cleavage between the Executive and the Legislative Branches, or between the two political parties.

Greatest interest has centered on the last of my listed categories, the one having to do with price-support programs for the so-called basic crops. The six crops designated by legislative fiat as basic bring in only about twenty percent of the farm income. But they account for eighty-five percent of the Federal inventory of price-supported commodities and for about ninety-five percent of the controversy. The remaining income, surplus stocks and controversy are distributed among some 250 farm products which have not been designated as basic.

In its recommendations regarding price and production policies, the Administration has not been doctrinaire, though it has often been charged with being so. Alternative recommendations have been made. The Administration has indicated that it viewed with favor the relation of price support levels to appropriate parity standards, if the Congress should so prefer. Or, if desired, supports could be linked to market prices of the immediately-preceding years. Or, should the Congress wish, the Secretary of Agriculture has indicated that he would himself bear responsibility for establishing support levels in accordance with general criteria.

With respect to production controls, the Administration has likewise avoided a doctrinaire position. A willingness has been expressed to support action by the Congress which would liberalize acreage allotments, eliminate them altogether, or to have the farmers choose between alternative programs. There has been an expressed willingness to administer a program of tightened allotments if the Congress should insist on keeping price supports at a high incentive level.

Throughout there has been this one important and consistent recommendation: that price support objectives be reasonably related to production policy. If price supports for wheat are to be held at a high level, Secretary Benson said a year ago, then strict production controls must be imposed. If price incentives are reduced, then a less restrictive production policy can be followed. The Administration indicated its clear favor for the liberal as compared with the restrictive route.

The one thing the Administration has consistently resisted is high price supports coupled with flimsy production controls—running the vehicle with the throttle wide open and without brakes.

III

Much of the controversy regarding farm policy springs from failure to distinguish between equity and workability. Both of these are important. No farm policy can succeed unless it takes account of both.

Let me state some appropriate considerations of equity.

1. Farmers, who are exposed to unusual economic and natural hazards, are entitled to the help of government as a cushion against unfortunate events which they cannot well avert through individual or organized action.

2. The cause of equity is not served by programs which aggravate the disparity of income *within* agriculture while endeavoring to reduce the disparity of income as *between* farmers and other occupational groups.

3. A man's role as a citizen takes priority over his role as a member of an occupational group. It is not equitable to do violence to his rights as a citizen, or to the rights of other citizens, in an effort to improve the position of his group.

4. Equity does not lie in the equal treatment of unequals.

Within the stated conditions of equity, there are workable farm programs. There is a substantial area within which equity and workability overlap. The Administration's farm policies are within this area.

Equity, like workability, is a necessary but not a sufficient criterion for success. Some programs are advocated as equitable, but are not workable and are of no service to agriculture. Other programs may appear to be workable in a harsh and callous sense, but do not meet the standards of equity which prevail in the mid-twentieth century; they will not be tolerated.

I wish to discuss the workability of farm programs, a matter which is the primary province of agricultural economists.

Here we run head-on into the fundamentals of demand, supply, and price. I shall state what seems to me to be the present state of professional knowledge on these points. If this seems elementary to you, I ask only that you note the grave difficulties that farm programs have come to by overlooking the fundamentals.

The law of demand is that, other things equal, an increase in price will result in a reduction in the quantity demanded; a decrease in price will result in an increase in the quantity demanded. I know of no exceptions to this law in the agricultural field.

Statistical evidence is very strong that for most farm products, in the short run, and with other things equal, a given increase in price is accompanied by less than a proportional reduction in the amount demanded. Thus, in the short run, a short supply will usually bring in a larger-than-average gross income.

The unchallenged statistical demonstration of this fact is the vision which has led to the production-control and price-support legislation now on the statute books.

But this vision, so clear in the short run, is proving in the long run to have been a mirage.

In the long run—and the long-run effect has been subjected to much less study—the relationship of price and quantity is far different from what it is in the short run. Over time and for many farm commodities, a given boost in price results in more than an equivalent reduction in the quantity demanded. Thus, in the long run and for many farm commodities, other things equal, a high price means a lower gross income to the seller.

The difference between the short-run and the long-run effect of a price increase is that over a period of time the buyer can find or develop substitute products or sources of supply. In the case of cotton, a price supported continuously and substantially above market levels has greatly stimulated the use of man-made fibers, and greatly stimulated the production of cotton abroad. During a quarter century of price support, the share of our farm income earned by cotton fell from twelve percent to seven percent.

During the five years prior to the inauguration of price support and production control, the six "basic" crops brought in twenty-one percent of our farm income. After twenty-five years of controls and supports, after the expenditure of many billions of dollars and the utterance of many millions of contentious words, these same "basic" crops still brought in only twenty-one percent of farm income, and a goodly share of this twenty-one percent was from sales to the Government.

It might be argued that in a free country, if a group of people wish to sacrifice the future to the present, that should be their prerogative. But at least they should know the result of what they are doing. And economists, who by their professional competence have this knowledge, should tell them.

Confusion with respect to the law of demand has made grave trouble for farm programs. But confusion with respect to the law of supply has led us even more deeply into trouble.

The law of supply is that if price is increased, other things being equal, a greater quantity will be offered. And if price is reduced, other things being equal, a smaller quantity will be offered.

This law is challenged by many persons. The statement is made that if price is reduced, farmers will increase production in order to offset the decline in income.

There undoubtedly are some individual farmers, with very limited alternatives, who react to some extent in this manner. But this is not true of farmers as a group.

I have studied all the research on this subject which I have been able to find. This includes the work of Bean, Black, Kohls, Moore, Nerlove, Pearson, Pubols, Warren, Wells, and others. Thus far I have not been able to discover any competent piece of work which shows the perverse relationship so often alleged to exist.

Some members of the Congress say that a price decline results in an increase in production. Yet when these gentlemen decided that fewer potatoes were needed, they properly allowed the price to decline. When they wanted an increase in production, as during the war, they properly raised prices. As recently as 1958 they extended the National Wool Act, the stated purpose of which is to stimulate production; the means by which this is to be accomplished is through offering increased prices. By their deeds members of the Congress recognized the economic facts of life as related to the law of supply.

Recently there has been some loose economic thinking with respect to changes in corn acreage. The statement is made that price supports were dropped and farmers increased their acreage in order to maintain their incomes. The truth is that price supports were dropped for about fourteen percent of the corn farmers, those few who had previously complied with their corn allotments. Supports were increased for the other eighty-six percent of the farmers. Farmers reacted in a perfectly normal and predictable manner. With price supports raised, with the corn acreage reserve program and corn acreage allotments abandoned, and with price supports for alternative feed grains reduced, a jump in corn acreage was practically certain. Farmers reacted in conformity with the law of supply.

Those who claim that farmers as a group increase production when price declines postulate a perverse and irrational situation. If farmers actually behave in this manner, crop acreage and livestock production are incapable of reaching or approaching equilibrium, and must, therefore, be subjected to strict government control or catastrophe will occur. Those who deny the validity of the law of supply are left without any explanation for the generally rational behavior of farmers who produce the unregulated crops and livestock products. Nor do they have an explanation for the generally rational behavior of farmers who produced wheat and corn and cotton during the centuries which preceded acreage control.

The fundamental laws of economics are these: Other things equal, as price rises, the quantity which will be produced increases and the quantity which will be purchased decreases. The Congress has not been able, in twenty-five years of effort, to set aside these laws.

I said these laws operate with "other things equal." But other things have not been equal. The special factor which has modified the operation of these laws has been the technological revolution in agriculture; this revolution has caused artificially supported prices to generate even greater surpluses than would otherwise have been the case.

The long-run consequences of artificially supported prices have set in. Supply has been increased, buyers have turned to alternative sources, markets have been lost, and farm incomes have been reduced.

If there is to be a better balance within agriculture, inducements for excess production must be diminished and pricing policy must allow farmers to regain markets.

Some people say that the solution lies in the direction of stiff controls. For twenty-five years the nation has been building up a history of experience with controls. The evidence is that the Congress will not enact, the Executive Branch cannot enforce and the farmers will not accept the kind of production controls which would be necessary to balance production and consumption at the price objectives customarily cited by those who advocate the strict controls.

If, with supplies as heavy and costs as great as they have been in recent years, stiff production controls could not be enacted, how likely is it that tough controls will ever be invoked?

Until someone develops evidence of a substantial change from the pattern of the last quarter century in political behavior and in American mores, this history must stand as an insurmountable refutation to those who advocate stiff production controls as a way out.

As we said before, we are in the midst of a technological revolution in agriculture. The need is to reap for society whatever gains this revolution may bestow, and to cushion its impact when it deals harshly with individuals and groups. Farm legislation has concentrated more on the problems of this technological revolution than on its opportunities. As a nation we have been problem-prone rather than opportunity-oriented.

Our rapid scientific advance has lightened the toil, lifted the level of living, and broadened the horizon for our farm people, and holds hope for a hungry world. This is good, not bad. To extract the most good from this revolution, and to be in a position to ward off its sharpest blows, individual persons should themselves have a substantial role in price-determination and in resource-allocation. The rapid changes which are under way call for a greater adjustment capability than is possible with the parity formula or an historically-based acreage allotment.

The heart of the Administration's farm policy is faith that individual farmers, with appropriate services provided for them by private and public agencies, will be able to make wise allocation of their resources—decisions that are advantageous to them personally and are in the public interest.

A technological revolution calls for the use of all the intelligence that is available. In the practical experience of four and a half million farmers there is a great reservoir of intelligence and sound judgment. A major purpose of the Administration's farm policy is to tap this reservoir.

The services I mentioned earlier are of great help in improving the caliber of individual decisions. Public programs can serve the national in-

terest better by helping to improve the caliber of individual decisions than by substituting government edicts for private judgment.

At the bottom of the income scale are a million and a half rural families who receive, from all sources, less than $1,000 a year. In terms of genuine need, this is the real problem. These people have been almost untouched by price-support and production-control programs. The technological revolution has largely passed them by. They do not contribute as much as they should or as much as they would like to the national production of goods and services. The Administration's Rural Development Program is addressed to this problem. It needs greater understanding, wider support, and more funds.

The Administration's Food For Peace program is an effort to use our abundant capacity for food production in support of the foreign policy of the United States. This is done chiefly through Public Law 480, the chief legislative authority for surplus disposal. During this past fiscal year, well over a billion dollars worth of American farm products moved abroad under our special export programs. Some of these programs are new, unique and unorthodox. They are not described in the standard texts on international trade. They have grown up out of necessity because our stocks were heavy and because dollars weren't available in the countries which needed our products. This program serves the needs of our friends abroad and relieves our heavy supply position. It is my feeling that Public Law 480, which has been considered by some as a province for idealists and temporizers, might better be considered as subject matter for hard-headed realists.

This then, restated in summary form, is the farm policy of this Administration:

For the farmers who produce the bulk of our food and fiber, a liberal production policy coupled with modest price objectives.

For rural people in areas of low income, services which will open wider the doors of opportunity both within agriculture and for off-farm employment.

For all farm people, services to improve the caliber of individual decisions.

For this generation and the next, land-use programs intended for wiser use of our national resources.

In the broad public interest, wide dissemination of the fruits of the technological revolution, to our own citizens and in the service of American foreign policy.

IV

What are the alternatives to the adoption of some such policy as I have outlined?

Continuation of the present program? Clearly the public patience will not tolerate indefinitely the heavy cost and the growing stocks which result from the laws we now have.

Stand by and allow the present program to collapse of its own weight? This would be a sadistic remedy. If the present program should collapse, with the mountainous stocks now on hand, prices of wheat and corn and cotton would be carried to disastrous levels. After having been insulated for twenty-five years from the rough-and-tumble of the market place, these crops can hardly quickly be tossed, unprotected, to the not-so-tender mercy of a completely competitive climate. We cannot regain overnight markets which we have been losing for a quarter of a century. Government has piled up the present stocks and is responsible for some of the present dislocations. Government cannot walk off and expect farm people to pick up the pieces.

Shall we apply marketing orders or some similar technique to additional crops and livestock products? Programs which have worked tolerably well for specialty crops in concentrated areas of production, marketed through a limited number of well-defined channels, cannot easily be extended to crops grown generally in diversified areas, moving to market in many forms and through many agencies. The so-called "self-help" plans thus far offered involve substantial government financing and responsibility. And it is not clear that government, while retaining responsibility for the domestic and foreign consequences of these plans, can legitimately delegate price and production authority to commodity groups. Nor can commodity groups avert the laws of demand and of supply which have brought government price-support and production-control programs to their present difficult state.

Should we enact two-price plans or domestic parity plans? If we do we institutionalize a wedge between the domestic and the foreign price, we set up government machinery for the transfer of added special monies from the eaters of food to the producers of food, and we set one faction of agriculture against another.

Shall we adopt production payments, or deficiency payments, or compensatory payments? Let us remember that the sole use to which this device has thus far been put has been the role of stimulating production, a consequence we do not want. Consider the likelihood that the Congress would dependably and consistently provide an annual appropriation running into many billions of dollars, to be paid directly and visibly to a vocational group which numbers only ten percent of the voting population. And let us think of what might happen to the market price, and hence to public cost, if an unsupported market is asked to move not only the abundant production of our present farm plant but also the added amount induced by a government payment.

There is, as I said earlier, a substantial area within which the separate disciplines of equity and workability overlap. Within this area the Administration's farm policies will be found. These policies will not satisfy those with their own special definitions of equity, or those who ignore the practical problem of workability. Nor will they satisfy those who see an opportunity to make "workable" some program which violates individual rights.

Whether the Administration's farm policies will satisfy a sufficient number of persons to permit corrective early legislation remains to be seen. Whatever time schedule the fates may hold, the day is gradually drawing nearer when farm legislation will be rewritten. It would be better to do this before the public patience is exhausted; it would be better to write new farm legislation in a climate of reason than with the attitude of resentment which further postponement would bring about.

MARKET STRUCTURE, ECONOMIC POWER AND AGRICULTURAL POLICY: A PROPOSAL FOR FORWARD PRODUCTION CONTROL

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YOUR Chairman asked me to participate in a debate on the Administration's farm policy. Dr. Paarlberg has chosen to present the affirmative side in support of the Administration's view, and I consented to present a negative. In many ways the choice of the word "debate" in the title of this session is extremely apt. Every debater knows that by the time the chosen topic has been kicked around for the season, there is not much that is new or surprising in substantive content. The current debate season began about two years ago and everything that I plan to say has been mostly said by myself or others at some time or other.[1] But good ideas are worth repeating in different words and for different audiences, especially in the area of public policy.

It must have been with a great deal of personal satisfaction that the Secretary of Agriculture wrote in his 1956 annual report, "In the surplus disposal program, flexible price supports, and the Soil Bank, we have most of the basic tools we need to help agriculture in its present emergency." However, in February 1959, in recounting some unpleasantries he said, "One of these is the fact that the present price support and acreage allotment programs, based on the results of over 20 years of experience, have obviously failed."[2] The failures of the Administration's program for commercial agriculture are obvious in the current stocks of wheat, the production and carryover of feed grains, and the costs to the Federal Treasury. To solve the farm problem and some of its currently unpleasant aspects, the Administration recommends lower price supports and the relaxation of controls.[3]

To borrow a lead sentence from Walter Wilcox, "Something has gone

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[1] To give credit precisely in each instance where it is due in any paper on agricultural policy becomes increasingly difficult. If a person were to identify the authors of statements on policy appearing recently in *Policy For Commercial Agriculture* (Joint Economic Committee, 85 Congress, 1st Session), *Problems and Policies of American Agriculture* (Ames: Iowa State College Press, 1959), *Journal of Farm Economics*, and reports of the National Planning Association, it would suggest the magnitude of our intellectual debt to one another.

[2] Statement of the Secretary of Agriculture before the House Committee on Agriculture, Feb. 10, 1959. Also noted in Raymond J. Penn, "Federal Agricultural Price and Income Policy, 1955-59," *J. Farm Econ.*, May 1959.

[3] Statement of the Secretary, *op. cit.*

wrong."[4] It should be evident that the policy of flexing support prices downward and moving toward the free market has not reduced production enough, increased consumption, reduced surplus stocks, and solved the farm problem. To this I add, "Something is still wrong!" The only policy the Administration prefers in 1959 is flexing support prices still lower and moving righteously toward an agriculture free of controls. After observing that gasoline poured on a fire makes a bigger blaze, would any reasonable person advocate gasoline for firefighting? This is the paradox that the Administration's view of agriculture presents and one that I hope to explain by pointing out that the Administration is not unreasonable; it is simply wrong.

The paper begins with an academic resume of market structure theory and proceeds to analyze the economic structure of both agriculture and non-agricultural industry. From this it is apparent that the Administration's policy makers have confused the market structure of agriculture with the economist's model of perfect competition. This mistake leads to their second mistake of identifying a free agriculture with perfect competition as a social norm. The paper ends with a proposal for forward production control that emerges from the analysis of agriculture using a market structure approach.

The Market Structure Approach

Accusing the Administration and its supporters of using "bad" theory and consequently "bad" practice in the name of modern market structure analysis requires specification of the latter. In the first place, it assumes there are many different kinds of markets, but that this variation can be accounted for in terms of more or less quantifiable factors. These factors constitute the structure of the market and are controlling in the model. What the structural factors "control" is the behavior of the firms in the market. Turned around, the theory says that the conduct of firms in any market can be explained by consideration of the structural attributes of the market. The final phase of analysis relates to the performance of the market as a whole which is the aggregate of firms' behavior with the interactions among firms taken into account.

Taken as a whole the theory seeks to explain the performance of an industry in terms of the conduct of the firms in the industry which are controlled by the structural features of the market. Not all the steps are necessary. Sometimes sufficient explanation of performance can be achieved through consideration of structure alone. However, the ultimate explanation involves all three considerations—structure, conduct of firms,

[4] "A Mistake in Problem Formulation and Its Impact on Farm Policy," *J. Farm Econ.*, May 1959.

and industry performance. Causation is generally assumed to flow from structure to conduct to performance. This does not prevent consideration of feedback in certain markets where the conduct of firms is such as to maintain or to alter the elements of structure.

There are three major features in the concept of market structure. They are the number and size distribution of firms, the class of product, and mobility of firms in and out of the industry. Other structural elements are the degree of vertical integration, the form of internal organization of firms, the amount and quality of market information, and the nature of the production process itself.

Sometimes the elasticity coefficients relating to supply and demand are included as a part of market structure. This may not be strictly correct. In many ways the existence, the meaning, and the values these coefficients may have are reflections of the interactions of the structural variables through firm behavior of the preceding paragraph. This emphasizes the necessity of going beyond the econometrician's structural parameters to basic features such as number and size of firms, product, and conditions of entry.

Study of a particular industry often reveals *ad hoc* elements of structure that are strategic in explaining performance at a particular time. These may be such things as a dominant personality in a leading firm, a "gentleman's agreement," or legislative restriction. Although the word is being used for every other literary title these days, the "anatomy" of an industry connotes the market structure approach.

Using the anatomic approach leads to considerations of conduct and performance. The economic distinction relates to whether the firm can operate in isolation or not, whether aware or unaware of interdependence among firms. The dimensions of performance include price, product, profit and its distribution, growth, and technological change. They are the aggregative aspects of the behavior of individual firms in the industry. By dissecting performance the investigator works his way back to the basic structures.

I wish now to apply this kind of analysis to a free agriculture, to a free nonagriculture, and finally to analyze the Administration's point of view within this framework. Interpretation of what is a "free" agriculture is necessary. The Administration seemingly uses the term to mean both the natural state of agriculture without direct government price and income programs and also the economist's model of perfect competition. No distinction is made between them in either a positive or a normative sense, hence both are viewed as congruent ends, the logic of perfect competition as a social welfare goal serving both. I interpret "free" to mean an agriculture free of direct government price and income programs.

"Free" meaning pure or perfect competition is different and will receive comment later.

The Anatomy of a Free Agriculture

What are the structural features of agriculture? Nine need mention. Large number of farms is a characteristic about which there is no disagreement. While there are small, medium and large size farms, it is also generally accepted that the size distribution of farms is such that no one farm typically has an output large enough relative to its market to influence price. Within their classes, agricultural products are generally considered to be homogeneous.

There may be more controversy about entry and exit. To establish a farm of efficient size requires a capital outlay of $100,000 and more in many parts of agriculture. Another barrier here may be the managerial skills necessary for this scale of operation. At the opposite end of the scale, capital and managerial requirements cannot be considered barriers to farming at the minimal census definition.

Actually, barriers to exit may be more important. Much has been written about the persistence of farmers in hanging on at low income levels. Although people are leaving agriculture in large numbers, many economists believe the migration is far less than that justified by economic conditions. Therefore barriers to exit are significant features of the agricultural adjustment problem.

The degree of vertical integration is an important structural element in certain agricultural sub-industries such as poultry but not particularly important in agriculture as a whole at this time. One feature of the internal organization of farm firms is worthy of note. Most farms are individual proprietorships and family businesses. The primary labor force is the farm family.

There is little doubt that farmers' technical knowledge of how to produce is excellent. Not enough is known about farmers' knowledge of economic variables and their magnitudes to make generalizations about market knowledge as a structural feature. Certainly substantial private and public services are devoted to supplying farmers with information about production techniques and about their markets. There is some evidence to suggest that farmers as sellers have less information than buyers of their products about economic conditions and the magnitudes of the relevant variables.

Production processes in agriculture are a distinctive feature of structure. They are biological, severely limited to nature's cycles and seasons, her catastrophes and bounties. Because of the discontinuities between inputs and outputs, production may be characterized as a batch process

in distinction to a continuous production line with a more simultaneous relation between inputs and output.

The low values of the price elasticity coefficients for demand and supply and of income elasticity must be noted. How low they are is a refinement that need not be debated here so long as there is agreement that their values are less than one.

Finally, an *ad hoc* feature of structure of great significance must be noted. It is the fact that in large part the research function and dissemination of research results have been institutionalized as a public service. No farm firm creates innovations for its exclusive use and decides the time rate of adoption as a component of its market strategy. Even the private research conducted by agricultural suppliers is made available to all farmers simultaneously.

What conduct may be expected of firms operating within such a structure? Significantly, the farmer will make his production decisions as an isolated firm because his output is small relative to the total. The farmer will be under compulsion to operate at full capacity of his labor resources. He will adopt innovations, even though output-increasing, so long as unit cost is decreased. The upshot of all this is that regardless of the level of price above variable costs, the farmer will seek to employ his resources fully, shifting among alternatives as their relative profitability changes. The pressure is always on to produce, if not one thing, something else. These results follow from the structural features of numbers, product, internal organization, and free access to research.

What are the outstanding performance characteristics of such an industry? One is the unplanned character of aggregate supply. When this is coupled with the sensitivity of the system (because of the elasticities) to exogenous variation, another result is unplanned and substantial instability in prices and incomes to producers.

The drive of individual farmers to innovate and produce always more creates a chronic situation of oversupply unless rescued by population growth, with consequent downward pressures on price when set against low demand elasticities. Continuing growth, development and technological change are not closely related to either individual market strategies or conditions of aggregate market demand. Industry output is not rationally planned for any particular result.

Technological change is a feature of performance and is primarily associated with the cost advantage to initial users and the fact that research and development costs are not borne by the individual, but the results are made available to all producers.

A final aspect of performance is that the industry's responses to changing conditions must necessarily be crude. Batch production processes do

not allow intra-seasonal supply adjustments. Biological production dependent upon physical circumstances does not lend itself to precise interseasonal adjustment. Impersonal market prices do an imperfect job of market coordination.[5] Each firm operates in isolation. Barriers to entry and, especially, to exit impede adjustment. Technological changes have no research cost, but once adopted are not given up.

The commercial farm problem is found in these aspects of performance. Supply instability involving movements along as well as shifts of the function is coupled with shifts in demand to produce price and income instability and economic insecurity for farmers. Also technological change shifting supply at a greater rate than population and income shift demand at the present time is continuing to force farm prices down. And farmers have no market power.[6]

As the next section will reveal, nonagricultural industry does have market power in substantial degree, and it is used. The dreariness of the proposals of the Administration's policy experts lies in part in their failure to recognize the facts of life about market power.

The Anatomy of Nonagricultural Industry

General attributes of the market structures of nonagricultural industries do not require much elaboration and must necessarily be treated briefly. In those industries supplying important inputs to agriculture, such as automobiles and trucks, farm machinery, chemicals, and oil, are found relatively few numbers of firms with some few having significant parts of industry output, differentiated products, and barriers to entry. Vertical integration is common, the corporation is the dominant form of organization, with hired labor. Market knowledge is as good as money can provide, and production processes are typically on a continuous line basis.

Individual firms become aware of market interdependence and conduct themselves accordingly. Individual market strategies become possible, and it is in the individual firm's interest to schedule output to meet a particular level of demand. Research is a part of market strategy and the timing of new products and use of new methods may be scheduled to market considerations.

The performance found in markets with these structural features will vary widely among industries. Typical results include nonaggressive pricing, product and service competition, output manipulation, market sharing, profit protection, etc.

Similar market structures are found in the industries buying from agri-

[5] Norman R. Collins, "Changing Role of Price in Agricultural Marketing," *J. Farm Econ.*, Aug. 1959.

[6] Robert L. Clodius, "Opportunities and Limitations in Improving the Bargaining Power of Farmers," *Problems and Policies of American Agriculture, op. cit.*

culture and in those industries distributing food and its products.[7] There is significant concentration, products are differentiated, vertical integration is substantial, and barriers to entry exist.

Although generalization is difficult, performance in industries buying from agriculture tends to be different with respect to output than in those selling to farmers. In buying, these firms often can use their market power to protect margins and to force back on producers the consequences of unfavorable conditions in their own markets.

The point to be made is that because structure permits, many more of the economic variables are subject to the administration of the management of the firm. These firms have market power. Market manipulation can be conducted with a high degree of sophistication at least as contrasted with agriculture. Through a combination of means and circumstances the planning of a line of action to accomplish a price-income goal becomes meaningful.

In industries like those selling supplies to agriculture where market structure permits and where the operation is consistent with the market strategy and conduct of the individual firm, output can be scheduled to the firm's revenue curve, and industry performance is characterized by control over supply. In language more colorful than that used by most academic economists, this is known as "gearing supply to demand," and it takes place in an imperfectly competitive market but one free of direct governmental intervention in prices and income.

Again this is an aspect of the use of market power by industry. It should be obvious that administered prices result, and they have great implications for the cost-price squeeze that is further reducing farmers' net incomes. Whether the market power of nonagricultural industry has been reflected in administered pricing of an inflationary nature is not settled. But in none of the Secretary's statements has there been a hint of recognition that market power of industry might be used directly to the detriment of agriculture. And further, in none of the Administration's proposals is there any recognition that market power exists, let alone has importance in agricultural policy.

A Mistake in Formulation

On various occasions and in various contexts the Administration and its supporters have espoused the virtue of "free" markets. It is suggested that the discipline of the free market eventually brings about a gearing of supply and demand at reasonable prices to producers. Here the Administration makes a grave mistake in acting as though agriculture and non-

[7] Recent research at the University of Wisconsin in market structures in dairy and food distribution fields supports this conclusion.

agriculture are alike economically, or would be if controls and supports were abandoned.

If the preceding analysis of market structures is valid, this "gearing" may be found only in the free markets of the nonagricultural, industrial sector of the economy. Industrial experience gives evidence that such firms and industries do, indeed, schedule production to market demands, often in the name of model changeover, market accommodation, inventory adjustment, or simply refusing to bargain in good faith when a union contract expires. This cannot exist in a "free" agriculture because of its quite different structure.

Now there are some segments of agriculture where attempts at scheduling production to meet market objectives are made. I refer to the specialty crops where state and federal marketing agreements and orders operate. They are "free" in the sense of no direct governmental intervention, but the police power of the state is invoked to bring about such a change in market structure that supplies marketed are brought under administrative control. Permissive legislation is the instrument for change.

The most charitable way to explain the Administration's mistake in model formulation is to charge it with confusing the market structure for agriculture as well as for nonagricultural industry with the model of perfect competition both in a positive and a normative sense. Perfect competition is not an adequate model for agriculture, and it is not an appropriate norm for either agriculture or nonagriculture, the Administration's apparent views to the contrary notwithstanding.

Reviewing the perfectly competitive model briefly in terms of its large numbers of firms, homogeneous products, and easy mobility of firms suggests something that could be mistaken for agriculture. If the mistake is not realized, it is easy for a person's thinking to leave the real world and to endow agriculture with all the conduct and performance characteristics of perfect competition. These would include market prices that are equal to cost including normal profit, production adjustment within and among firms through exit so that supply and demand are equal at satisfactory prices. Any displacement from equilibrium brings about automatic, swift, and precise restoration of equilibrium again at prices covering the costs, including normal profits, of producers.

From this point the Administration easily makes another mistaken shift to the welfare norms of the model. The equilibria are presumed to be consistent with an optimum allocation of resources, most efficient production, and payments to factors in accordance "with what they are worth."

Both of these mistakes lead to policy proposals that presume to be good for farmers whether they know it or not and also good for society. This is the best of everything. Its consequence is that the Administration favors

going from high supports to lower supports, to even lower support based on recent market prices, to freeing agriculture so lower prices will increase consumption, simultaneously reduce output, and the production machinery will be back in gear. It leads to a conviction that getting the government out of agriculture is an end to be sought as perfection itself.[8]

These proposals are mistakes because the competitive model is inappropriate for the problem. Consideration of the market structure of agriculture should be convincing on this score.

Exit is not easy from agriculture. Because of the lack of realistic alternatives, farm labor resources are not sufficiently mobile. Knowledge is not perfect. The arts are not static, as the technological revolution eloquently testifies. Yet easy exit, substitutability and perfect resource mobility, perfect knowledge and the static state are the factors that bring about the elegance and beauty of the equilibria in perfect competition where supply is geared to demand at prices including normal profits. In spite of this the Administration and its supporters cling to perfect competition as the model of what agriculture is and ought to be.[9]

The Administration is also revealed to be in an inconsistent position. Getting the government out of agricultural price and income programs and back to the free market is one kind of policy. Having agricultural supply geared to demand at reasonable prices is another policy. Pursuing the first does not accomplish the second.

A Proposal for Forward Production Control[10]

Interestingly, market structure analysis indicates how the second may be accomplished. It requires a change in structure so that within the calculus of the individual farmer is included consideration of the aggregative effect of output on price. This means production control forward in time. More significantly it means specifying levels of output to individual producers such that they will plan and control their inputs and combine factors most efficiently for the specified output.

Because of the great diversity to be found within agriculture's sub-

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[8] Speech prepared by the Secretary of Agriculture before the Rural Development Program Workshop Conference, Jackson's Mill 4-H Camp, Weston, West Virginia, May 11, 1959.

[9] My colleague William Lord expresses himself as follows at this point: "Now that the profession has intellectually excised the will-o-the-wisp of normative theory perhaps it is time to wean our language and eventually the conventional wisdom away from it as well." We agree except for my belief that more surgery may be required within the profession.

[10] This might be viewed as the production side analogue to T. W. Schultz and D. Gale Johnson's "forward pricing." Their scheme involved a price goal to which production responds *ex post*. Scheduling production forward to meet expected demand and needs with price an *ex post* result seems more feasible and realistic.

industries, a common structural change with a single technique of control is likely not appropriate. Each sub-industry such as dairy, wheat, livestock, fruits and vegetables has its own market structure that requires analysis before structural changes leading to production control can be recommended. The method of control should be tailored to the commodity. Extensions of the techniques of control involved in state-federal marketing agreements and orders should be considered where appropriate. The Sugar Act, whose extension the Administration paradoxically recommended so enthusiastically,[11] contains constructive suggestions for other commodities. Research is going on in several places on production control largely in response to Cochrane's challenging work and his concept of transferable certificates.[12]

The mention of supply control for agriculture sometimes elicits a strange response. Those not in favor of it place the adjective "rigid" before it, assume it always means arbitrary and undemocratic restriction, and always categorize it as an "extreme" position. These would all likely be accurate characterizations if supply control were cast in a structure of textbook single firm monopoly. Because there are large numbers of farmers, because products have close substitutes, because there are intertemporal demand relations, because supply responses can be induced, etc. single firm monopoly output manipulation can never be a realistic goal of even the most ardent proponent of supply control for agriculture.

Control here means administered choice of the magnitude of output. It must be flexible to meet changing economic conditions. It may be administered at higher or lower values depending upon the relevant elasticities, demand and supply, short and long run, and other attributes of structure. It can hardly be extreme because control over environment has long been man's dream and rationale for much of his research.

If the preceding analysis is correct, agricultural production might be geared forward to meet national goals in varying degrees yet to be determined. It would require the specification of national food and fibre production goals according to certain criteria set up by Congress. Among those to be considered should be the meeting of domestic and foreign demand requirements consistent with reasonable prices. What are reasonable prices would be defined by Congress. It is here that conflicting interests are resolved, but prices should be at levels to maintain adequate returns to human resources. Another criterion is meeting reserve requirements associated with uncertainties of all kinds. Being able to hit a chosen output goal requires a degree of precision that is not possible because

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[11] Statement by Secretary of Agriculture, Ezra Taft Benson, before the House Committee on Agriculture, February 10, 1959.

[12] *Farm Prices*, Minneapolis: University of Minnesota Press, 1958.

of the nature of agricultural production. A flexible storage program could be designed to meet this and other unusual supply or demand conditions, including a harvest that did not meet expectations, emergency relief needs, or war. A third criterion involves meeting international commitments. Forward looking commitments to less developed countries of certain quantities of food for a specified length of time could do much to help them with development problems on a positive basis. Food is shifted from a liability of disposal to an asset with which to build.

There is great talent, good research and already considerable experience in the United States Department of Agriculture that could be drawn upon for the specification of national food and fibre goals. In the early period these grew out of wartime problems to stimulate production.[13] But increasing something is just as much an aspect of control as reducing it. My point is that this nation needs a food and fibre policy in which an important element is attempting to gear production forward to meet national goals. A positive program such as this could be working in the national interest in 1965 or 1975 with the same validity that it could bring to the problem today.

This does not seem to be the time nor occasion to attempt to answer the questions that might be raised against forward production control. There are legitimate questions relating to the short and long run income distributive effects within agriculture because of capitalization, and between agriculture and nonagriculture; relating to the efficiency of resource allocation; and relating to administration. There may also be wilder charges about monopoly, socialism, and farmers in chains. All suggest only that they need analysis.

Forward production control as envisaged here is not a permanent solution to agriculture's problems. There is no such thing as a permanent one-shot solution to the problems of an industry with a structure such as agriculture that is undergoing rapid change. But, because of its structure, agriculture is prone to continuing price-income problems. Forward production control offers the possibility of *continuing* solutions through bringing under control one more variable in the economic environment, and supply is especially important at the present. It does not come to grips with problems of the low income groups within agriculture. But it does generally enhance farmers' bargaining power.[14]

Forward production control may have some advantages in the political economy. It has the prospect of bestowing upon agriculture the freedom

[13] In this regard the sessions reported upon in the Proceedings Issue, *Journal of Farm Economics,* February 1943 are extremely interesting. In recent times the work of Rex F. Daly, "Prospective Demands for Food and Fibre," *Policy for Commercial Agriculture, op. cit.,* is a relevant example.

[14] See Clodius, *op. cit.*

of gearing supply to demand that is characteristic of the "free" nonagricultural industries. If having this attribute is good for nonagriculture, surely this freedom is desirable for agriculture although the instrument required for agriculture to be free is government.

More important than the preceding play with words in the political context is the fact that forward production should prove to be a low-cost-to-the-government program. Conceivably price supports could be retained as the minimum wage legislation for agriculture, but with competent administration of forward production they need not be used to an important degree. Accordingly, out-of-Treasury costs would tend to be reduced. If subsidization of food for peace and development in less developed countries were involved, the costs would be attributed to the State Department, not Agriculture. The irony of forward production control is that it meets the Administration's understandable criteria of free and low Treasury cost but may be unacceptable to them because it does not meet the nonsense criteria of perfect competition.

Perhaps the most important thing about forward production control is that it places the policy emphasis on production instead of price. Society is appropriately concerned with the prices and incomes received by farmers, but society should be most concerned with a food and fibre policy. To my knowledge there is no such policy that is operational. At the present time storage stocks and reserves are *ex post* results of a price program. The Administration can think of nothing but getting rid of them in the short run, and the public is instructed to view them with alarm. With forward production, reserves against errors, weather, and war and stocks for economic development become rational parts of a long run public policy.

In a public speech this year the Secretary of Agriculture said,[15] "I say bluntly that the overwhelming majority of agricultural economists and other students of this problem endorse what we are trying to do as sound and best for agriculture." He also quotes in support of the Administration's program a survey in which "Of the 37 economists replying, four out of five say that 'any laws further ham-stringing the free market will hurt the farmer, the consumer, and the nation.'"[16]

I cannot believe such statistics are the parameters of the population. In the belief that the samples are as bad as the Administration's theory, and especially as a point of issue with their 29 and 3/5's economists, I conclude that the Administration's theoretical formulation is inadequate, involves a basic mistake and inconsistency, leads to proposals that have not and are not likely to solve the farm problem, and reflects either ignor-

[15] Rural Development Program Workshop Conference, *op. cit.*

[16] As J. K. Galbraith has pointed out, economists have their preconceptions also: "Economic Preconceptions and the Farm Policy," *Amer. Econ. Rev.*, March 1954.

ance or wanton disregard of principles of market structure theory and industrial experience. This represents an independent point of view, grounded in market structure theory, that hopefully will come to be offered by more than few sellers to few takers as the farm policy debate continues.

THE FARM POLICY DEBATE: DISCUSSION

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Criticism comes quickly from those of us who are not burdened with the responsibility for public acts, pressed by a feverish immediacy, tyrannized by tight deadlines, or subject to unrelenting political attack. Nevertheless, and with all deference due Dr. Paarlberg, I am duty-bound to catalogue certain major shortcomings in the Administration's farm program:

1. At the outset, there was endorsement of an excessive parity standard, against which some modest achievements could register only as dismal failure. Little progress has been made towards formulating attainable goals appropriate to present-day farm conditions.

2. The dimensions of the surplus problem have been repeatedly underestimated. This has been reflected in overemphasis on gradualism, and in the promise of too much freedom to plant, too soon, and at too little price decline.

3. A policy commmendable for having faced up to hard political and economic facts has yet suffered from a certain lack of candor. Transitory improvement in the current agricultural situation has too often been claimed as evidence of program success, until events proved otherwise. If the charge is now made, mistakenly, that the record 1959 corn crop is a consequence of lower price supports, the Administration must itself bear some of the responsibility for widespread misunderstanding of the relevant facts.

4. Positions taken up with conviction and held with firmness have on occasion become unduly rigid. Several important instances warrant mention. A policy taking the hard but virtuous road through short-run sacrifices towards long-run gains has lost possible support for lack of positive measures to ease transitional difficulties. Advocacy of a more rational price structure for farm commodities has sometimes seemed to imply that there is no separable income problem for commercial farmers. The goal of a liberal agricultural program might have been approached more quickly by measures less voluntary in their initial impact.

5. At the other extreme, too warm an endorsement has on occasion been given to expedients forced upon the Administration by hard political realities, even while important principles were being compromised.

6. The magnificent research resources of the United States Department of Agriculture have been called upon for far less than their optimum contribution to evaluation of past programs and appraisal of new proposals. Research efforts along just such lines were urged upon a conference of this Association by high authority in 1957.

To Don Paarlberg's experienced ear, these objections may suggest counsels of perfection and knowledge after the fact. That they add up to a troublesome list is itself a kind of virtue, for there has indeed been a sustained line of agricultural policy from which aberrations might be measured. And since the word "independent" appears in the sub-title of this session, I would call attention to the high caliber of independence required to defend the policy positions with which Dr. Paarlberg has been associated these past seven years. Let the academician always exercise equal courage when conflicting claims are made upon his scholarly conscience!

In turning to an instrumentality like tight production or marketing controls, we must make due allowance for the hearty enthusiasm of proponents, like Professors Clodius and Cochrane, as well as for the opposite biases of the excessively timid. The gap between speculative inference and substantiated fact is necessarily wide, and one reasonable man's "myth" is another's categorical imperative. It is certainly true that acreage restrictions and land retirement are ineffectual forms of coping with surplus agricultural capacity when the modern alchemy can transmute minerals and steel into food and fiber. But marketing agreements have heretofore succeeded where the pattern of supply closely approximated conditions of natural monopoly, which is hardly the situation for major field crops. The sugar program is frequently cited as a prototype, but the market structure for sugar beets and cane is decidedly atypical. In particular, special relationships between individual growers and a limited number of processors make administration of market controls unusually easy.

Beyond this, it seems to me that on three fundamental points the Administration is clearly right and Clodius seriously in error. First, the economic logic of the present situation strongly argues for lower farm prices, not higher ones. The technological transformation of American agriculture, about which so much is written, surely implies a decline in the real costs of producing farm commodities. In longer historical perspective, recent cost reduction may well compare favorably with those resulting from the opening up of the prairies in the nineteenth century, and

appropriate market prices could involve major shifts in the volume and composition of commercial exports. Thus far, we have largely denied ourselves the advantages of lower prices, but instead have permitted the gradual inflating of cost structures. While once there was concern over "capital rationing" in agriculture, we have of late encouraged excessive rates of capital investment. The legacy of unwarranted investment is of various undesirable sorts: the operator becomes committed to a higher level of cash expenditures in subsequent periods; computed depreciation charges rise, and subsequent estimates of net farm income are accordingly reduced; we can confidently expect future requests for Congress to insure a standard rate of return on imprudent investment; and, as agricultural-supply industries become attuned to higher rates of sales, problems of excess capacity spread out to other economic sectors. Greater mobility of labor will benefit agriculture little if overcompensated by capital inflow.

Secondly, reliance on market prices to induce needed adjustments does have genuine advantages over more direct, more coercive, controls. These advantages commend themselves to liberal and to conservative, to capitalist, communist, and Keynesian; rarely have they been expressed more forcefully than in Keynes's own *General Theory*. It is surely possible to make better operational use of the price mechanism without relying exclusively on the incomes generated by free-market prices. Unfortunately, short-run price protection is a typical response of public policy when market factors adversely affect particular commodities, farm as well as nonfarm. But agriculture has been plagued by commodity-itis in an especially virulent form. Artificially high prices mean high marginal incentives to produce and to that extent are in direct conflict with efforts to restrain output or marketings.

Thirdly, the Administration has properly argued that high price supports are not a satisfactory device for redistributing income to agriculture or within agriculture, and marketing controls are similarly defective. Such public subsidy or aid as is funnelled to the farm sector needs to be granted according to a more rational principle than strict proportionality to volume of marketings.

While skepticism concerning Professor Clodius's proposal is accordingly justified, every serious effort to invent improved farm programs is much to be welcomed. In agriculture, and not in agriculture alone, changing circumstances and rapid advance in technology require major modifications in our key statistical indicators, in our preconceived ideas, and in our inherited institutions. Consider the statistical front first. The statutory parity ratio becomes seriously misleading as the number of farm people declines and agricultural efficiency rises. What significance should be

given to a series on farm operators' net income when depreciation allowances approach 50 percent of the net figure, asset values are at record levels, and off-farm sources of income become increasingly important? This commingling of farm and nonfarm activities even complicates the definition of a farm as a distinctive occupational or residential category, at the same time that city and countryside become more alike in production skills, amenities of household operation, and basic cultural environment.

The policy implications of one statistical series are especially interesting, that on net outmigration from agriculture. The cumulative total since 1935 is roughly equal to the number of persons remaining in agriculture. Low-income folk from the South have contributed heavily to the outmigration figures. In decades past, that particular group served to artificially depress national estimates of farm income per capita, a statistic of which much political capital was made. Ironically, the numerical decline of more recent date for this same population group now biasses the per-capita averages in the opposite direction. Meanwhile expensive programs for farm commodities, justified in the name of agricultural disadvantage or poverty, have diverted public funds and energies from serious social problems in the major metropolitan centers to which millions of these very farm people have in fact been drawn.

Farm policy in the more limited sense can benefit from a sharp distinction between measures that regulate productive capacity and those that support operators' income. Confusion between these two objectives is at the root of much of our present difficulty. We are in need of income programs that face up to the realities of present-day agriculture. The high productivity of some cheap inputs and the further technological improvements that are in clear prospect must affect market prices sooner or later. We are entitled to look with suspicion upon any devices that make continued output of unneeded crops a condition of receiving public funds, or that keep the grower completely insulated from the low returns realized through surplus disposal. With production expenses absorbing so large a proportion of total receipts, overt transfer payments become an increasingly attractive alternative. By shifting the emphasis to net income of individual farm operators, we can take proper account of the particular contribution that off-farm earnings make to the well-being of low-income farmers, and we can specify an appropriate ceiling on the size of individual income that is of direct public concern. Social ingenuity can surely devise programs that provide solid benefits for farm people while avoiding the familiar pitfalls of commodity parity.

THE FARM POLICY DEBATE: DISCUSSION

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Both Dr. Paarlberg and Professor Clodius are to be commended for their conscientious efforts in doing precisely what they were asked to do—debate the Administration's Farm Policy.

First let us look at an important difference and a similarity in these papers. Both authors attribute the upward shift of the agricultural supply function to changing technology. This is the commonly accepted notion in farm policy discussions today. But we typically define "technology" so broadly or so vaguely that I doubt if we really know what we mean by this term. Operationally we only too frequently act as if all increased productivity (and sometimes even production) were derived from newly discovered machines, plant varieties, and other new physical inputs and new forms of output—and as if all increased agricultural productivity found its cause within agriculture. Peter Drucker points out that the gains in productivity in our society in the last decade have come primarily from new "concepts" of organizing the production process and only secondarily from new physical technology. Similarly, in agriculture I would submit that we have been experiencing as much an organizational revolution as a technological one.

It is in the nature of the theoretical structures they posit that the two papers take diametrically opposed positions as to the mobility of factors: Paarlberg's discussion implies perfect or near perfect mobility and Clodius assumes very low mobility of factors. It is important to note that it makes a great difference in the design of farm policy which of these theoretical descriptions you accept.

Agricultural economists are, I think, at this juncture quite generally critical of the Administration's economic position as exposited by Dr. Paarlberg. In my view there are basically three things wrong with the Administration's position: (1) They design policy around obsolete economic constructs. (2) Some of their "facts" of economic and political history are wrong or at least misinterpreted.[1] (3) The Administration's actions in some cases do not jibe at all well with their stated intentions or goals.

Obsolete Economic Structures

As exposited, the Administration's Farm Policy is a rational economic policy only if you accept as realistic for the economy the perfectly com-

[1] Some would distinguish between this and what can be described as mistaking "values" for "facts." See Walter Wilcox, "The Farm Policy Dilemma," *J. Farm Econ.*, 40:563, Aug. 1958.

petitive model of classical economics. Dr. Paarlberg makes this painfully clear. I do not see how one can do anything but reject this model as obsolete, unreal, and naive, particularly when used as the warp and woof of policy formulation. The Administration establishes again Lord Keynes' dictum that where economic problems are concerned most men of affairs are the intellectual captives of long dead economists. They view reality through an optic of superseded economic concepts. After all, the ideas of Cournot, Bertrand and Edgeworth were current in the last part of the 19th century, and the ideas of Keynes, Hicks, Chamberlin, Mrs. Robinson, Triffin, Clark, Von Stackelberg and Fellner, to mention only a few, are neither obscure nor revolutionary today. Nor can one fail to point to William H. Nicholls' book, *Imperfect Competition Within Agricultural Industries,* published in 1941, which concerned itself directly with agricultural markets. The ideas of these men have for some years been the standard materials of any competent graduate program in economics.

Fiction and Fact

Some of the "facts" as pronounced by the Administration and repeated for us by Dr. Paarlberg are either wrong or misinterpreted.

The claim is made *ad nauseam* by the Administration that war-time price support levels were maintained by Congress after 1948 even though the 82nd Congress had passed legislation providing for a reduction of price support levels. This is not true. The percent of parity at which support levels were established was lower in 1949 than in 1948 for barley, dry beans, cotton, flaxseed, sorghum grains, and wheat. The support level in 1949 was below the war-time support levels for all of the above commodities plus cottonseed, soybeans, air-cured and fire-cured tobacco and wool. This leaves only oats, peanuts, rice, rye, corn and flue-cured and burley tobacco for which the percent of parity support level had not been dropped by 1949.[2]

Support prices have two types of direct economic effect, one a price, the other an income effect. The evidence available indicates that the influence price supports have had on agricultural capacity has operated primarily through the overall enabling effect of additional income provided farmers and not through price-directed resource allocations. Yet it is in the name of the direct price-caused resource *mal*allocations that the Administration condemns past and current price supports. I believe this indicates an inadequacy in economic reasoning as well as inattention to the statistical evidence.

In addition, it makes a great difference in the function and effect of

[2] "Price Programs," *Agriculture Information Bulletin No. 135,* USDA, Washington, D.C., 1957, pp. 80-109.

price whether you are speaking of a movement up the supply function or down. Glenn Johnson's analysis of asset fixity and the nature of the downward side of the supply function in agriculture indicates very great, if not insurmountable problems in squeezing out redundant resources through the agency of lower farm prices.[3] Those in the Administration and out who are addicted to pre-Marshallian formulations of the laws of supply and demand, and who would put agriculture through the wringer of immediate free market prices, would do well to read Professor Johnson and reflect on the possible ineffectiveness of this approach, particularly when the best estimates we have indicate such action would result in at least a 25 percent and possibly as much as a 40 percent decline in income to agriculture.[4]

I hope Dr. Paarlberg does not intend to imply that supporting the "basic" crops is in effect providing support only for the roughly twenty percent of farm income derived from these six crops. This is a statement one frequently sees in the Secretary's speeches. The only trouble with it is that it is wrong. As any Midwestern farmer knows, the feed-livestock economy is rather closely intertwined, to say the least, and to leave out the effect of "basic" crop supports on income from livestock is to leave out the effect on 55 percent or better of farm income. And one could pursue this through other structural interdependencies and substitution possibilities. Walter Wilcox estimates that price support activities have since 1952 provided about one-third of all realized net farm income.[5]

The Administration is described as an innocent but injured bystander to the legislation passed by Congress and thus not responsible for the present farm laws. This is said to be so, apparently because none of the Administration's legislative program was accepted by Congress *in the form in which it was submitted.* By these standards no administration since James Monroe and the "Era of Good Feeling" can be held responsible for much of anything in the way of legislation. In farm policy the present Administration has obviously not had its way with Congress, but many of the Administration's legislative proposals (the soil bank, for

[3] Glenn L. Johnson, "Supply Function—Some Facts and Notions," *Agricultural Adjustment Problems in a Growing Economy,* Iowa State College Press, Ames, 1958, pp. 74-93.

[4] Walter W. Wilcox, *op. cit.* Agricultural economists at Iowa State recently estimated that return to a "free market" even with present surplus stocks still impounded would result in the price of wheat falling to 74 cents a bushel, corn to 66 cents a bushel and cotton to 21 cents a pound. See *U S News and World Report,* December 14, 1959, p. 105. For the original research see Arnold Paulsen, *et al.,* "Projections for the Feed-Livestock Economy 1959 to 1963 with Free Prices and No Controls," *General Economics 154,* Center for Agricultural and Economic Adjustment, Iowa State Univ., Ames, 1959. Strikingly similar conclusions were reached in the so-called "Ellender Report" (Senate Doc. No. 77, 86th Cong., 2nd Sess.).

[5] *Op. cit.,* p. 564.

example) were clearly in an unworkable form as submitted to Congress.

We are also told that "recently there has been some loose economic thinking with respect to changes in corn acreage." I could not agree more. Price supports were dropped this past crop year for the fourteen percent of farmers who had previously complied with their corn acreage allotments, but supports were actually increased for the other eighty-six percent of the farmers. Acreage allotments were dropped entirely. Amazingly, this was explained by the Secretary as another sure-fire way to reduce the surplus through application of the universal and inexorable law of supply and demand. However, it would be difficult to convince many newspaper readers that the Administration had its theory and the facts in focus very long before corn harvesting ran an empirical test of the question.

Consistency of Words with Actions

The Administration has set for itself and the nation some very commendable goals in farm policy. Since we are prevented by a Congress controlled by another party from observing these goals directly translated into legislation, it is only fair to ask how well the Administration's stated goals compare with various actions taken in making recommendations to Congress and in administering existing legislation.

The Administration admits to the responsibility for faithful administration of the laws as enacted by Congress, and asserts that they do "not know of any serious charge" that the Executive has failed "to administer our farm laws as enacted by the Congress." Perhaps so, but one is reminded of the spectacle of the large dairy product processors refunding millions in government payments following one Congressional inquiry. And what of the hard words exchanged when the soil bank was consciously used by the Administration as a direct crop insurance device in 1956—an election year. Or what is one to make of the pleasantries that have passed between the Administration and Congress over the Executive's refusal to use Section 32 and other funds allocated by Congress for such things as relief and school lunch?

Dr. Paarlberg provides a list of nine policy goals that "constitute the Administration's farm program." The sixth item in this listing is described as the support of credit programs for the farmer. Far from strengthening or extending the farm credit activities of the government, the Administration has fairly consistently acted to restrict or dismantle certain of the inherited programs. A case in point is the Farmers Home Administration (FHA) which was founded under the Bankhead-Jones Farm Tenant Act to make production and mortgage loans to tenants and low income farmers. Not only has the Administration requested reduction of loan authorizations for FHA, but the word "low-income" does not even appear in the

FHA administrator's annual reports of recent years. Financial operations of the agency reflect a major change in purpose without the legalizing benefit of new legislation.[6] The average size of initial production loans has more than doubled under the present Administration. The average net worth of initial borrowers has increased to the point where it is obvious that the clientele to which FHA is now addressing itself are primarily commercial farmers. There is nothing unprecedented among administrations with actions such as this, but it does not overwhelm one as an example of "faithful" administration of the laws as enacted by Congress. Nor does it suggest that the Administration has a burning interest in the welfare of low income families in agriculture.

Second in the Administration's list of its farm program is the "Rural Development Program by means of which we endeavor to open wider the doors of opportunity for the million and a half rural families with very low incomes." Economists who have made direct evaluations of this program conclude that while the idea is in general excellent the effort has been so minescule that the "door" can hardly be said to have been "opened."[7] One can only wonder then about the high seriousness of the Administration's original intent when it so energetically fought the Douglas bill, which would have considerably expanded the Rural Development Program.[8] Indeed, the President has already vetoed this bill once, apparently because it would cost money.

The ninth area of the Administration's farm policy is described in these words: "for the problem crops, particularly wheat, legislative changes are proposed which move in the direction of greater freedom to plant and less interference with market forces." Congress has not as yet unleashed the Administration to act on these proposals. Nor is it likely to if, as was recently estimated in the *Journal of Farm Economics*, the Administration's proposal would increase significantly the cost of the wheat program without reducing surpluses.[9] The Administration apparently wishes to repeat in wheat the price support miscalculation that they created in corn in this past crop year.

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[6] The Administration has a bill in the Senate now that would resolve this inconsistency, Senate Bill No. 2144.

[7] William H. Nicholls, "Rural Low-Income and Rural Development Programs in the South," *Proceedings of the Mid American Conference on Migratory Labor*, St. Louis, April 7-9, 1959, pp. 23-32. See also V. W. Ruttan and J. K. McDermott, "How Effective is Rural Development?" *Farm Policy Forum*, Iowa State Univ. Press, Vol. 11, No. 1, Summer 1959, pp. 25-31.

[8] Senate Bill No. 3683 for 1958 was vetoed. Senate Bill No. 722 for 1959 passed the Senate and is now in the House.

[9] Curtis C. Harris, Jr., "Eisenhower's Wheat Program: An Estimation of the Treasury Cost for 1959," *J. Farm Econ.*, 41:815, Nov. 1959, pp. 815-820. This is a rough and ready sort of an estimate, but very large margins of error could be accomodated without changing Mr. Harris' general conclusion.

We are as a nation indicted by Dr. Paarlberg as problem-oriented when we should be opportunity-oriented. This comes as an interesting suggestion when one remembers that the Administration's explanation for the shattering dismemberment of the old Bureau of Agricultural Economics (as well as other professional groupings in the USDA) was the urgent need to make the entire organization problem-oriented.

Because it is the Administration's farm policy we are debating, I have limited my discussion primarily to Dr. Paarlberg's paper. However, before we make agriculture a public utility, and that essentially is what Professor Clodius has proposed here and Willard Cochrane has proposed elsewhere, I would like to hear adequate answers to a number of questions and problems.

The approach depends in part upon the very low mobility of factors which it posits. This immobility can be exaggerated and usually is when labor, particularly, is under discussion. Here I think our recent farm migration history is being badly misread. However, even granting low or zero mobility, how will one prevent the original income gains from the creation of market power from being capitalized into fixed factors such as land or into the transaction value of the "quota certificate"? And if this happens have you not by raising the cost structure compounded the already great difficulties of entry, exit and resource adjustment? How do the proponents of the public utility approach propose to control entry into farming? This must be done if the system is to work.

Also, before accepting an approach such as Professor Clodius and others suggest, we need to know quite explicitly how the feed-livestock economy would be handled. This has yet to be explained adequately by the proponents of the "public utility" approach. In many ways this is the acid test of any farm program today.

Finally, how is it proposed to handle the problems associated with the export markets, particularly for such important commodities as wheat and cotton?

The public utility approach as exposited to date leaves unanswered so many questions of major order that I suspect the prescribed cure, no matter whose variation is accepted, would probably produce at least as many problems as it solved. The protagonists of the public utility approach, I think, tend to limit the range of their analysis to that encompassed by imperfect-market theory. And while imperfect-market theory provides a far more accurate description of modern agricultural markets than a pre-Marshallian formulation of classical economics, it was never designed to encompass more than a small part of the reality that is agriculture.

AGRICULTURAL SUPPLY ANALYSIS*

CHAIRMAN: MARC NERLOVE, UNIVERSITY OF MINNESOTA

THE STATE OF AGRICULTURAL SUPPLY ANALYSIS

GLENN L. JOHNSON
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IN 1956 Professor T. W. Schultz wrote, "We have no meaningful estimates of the price elasticity of the supply" (presumably for all as contrasted to individual products). He continued, "The striking difference in what we know about the demand and what we know about supply has not come about because one has received our attention while the other has been neglected. The difficulty runs much deeper than this. For a function to be useful it must either be stable over time, or we must be able to predict how it will change." In a footnote he attempts to clarify his position by stating that this "does not imply that we can predict the growth of the labor force, the additions to the stock of reproducible capital and the further 'discoveries' of non-reproducible factors; this is not the task of a theory of supply. What our statement does say, however, is that with a particular set of such resources at hand we are not able to observe any dependable price elasticities for the supply, or with particular increases in such resources, we are not able to observe any stable relations between such increases in resources and increases in production."[1] Professor Schultz then explored the possibility of explaining excesses of incremental outputs over incremental inputs "(1) by the new techniques that are adopted in production and (2) by improvements in the labor force, that is, in the quality of the people who engage in production."[2]

A Review of Supply Work to Date

Before accepting Professor Schultz's assessment of the state of agricultural supply analysis and dependent estimates, it seems advisable to set his statements in the perspective of both earlier and later contributions to the literature concerning agricultural supplies. The body of literature can be divided into two parts dealing with (1) the overall production or

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* Joint Meeting with the Econometric Society. This paper has benefited substantially from criticisms by William Ruble.

[1] T. W. Schultz, "Reflections on Agricultural Production, Output and Supply," *J. Farm Econ.*, 38:749-50, Aug. 1956.

[2] *Ibid.*, p. 759. The inconsistency between saying that the theory of supply is responsible for predicting changes in technology and educational levels but not for predicting changes in the size of labor force, capital stocks, and 'discoveries' of nonreproducible factors has not bothered Professor Schultz and it need not bother us as it is a minor point.

supply of farm products and (2) the production of individual farm products.

Work on overall supply responses

The literature on overall supply responses prior to 1958 was summarized in *Agricultural Adjustment Problems in a Growing Economy.*[3] That summary of the work of many prominent agricultural economists, including several books and articles by T. W. Schultz on supply, substantiated the Schultzian conclusion that work on *overall* supply responses had been rather inadequate.

The summary revealed a widespread use of neo-classical concepts in both theoretical and empirical work with modification to take into account such considerations as inflations and deflations, weather, technological advance, capital movements, risk and uncertainty, trends in wage rates, differentials between rural and urban population increases and fixed costs. The failure of such modifications of the neo-classical analysis to produce adequate supply estimates suggests, at least, that the task may be one of changing the neo-classical analysis.

The summary discussed above does not include several important works some of which have been produced since the summary was written. Professors John D. Black and James Bonnen have predicted the supply of and demand for farm products in 1965. Estimates of yields, acreage and changes in the productivity of livestock were built up, more or less, commodity by commodity. Similarly, demand estimates were constructed by commodity groups. Apparent structural imbalances were studied. The result was a prediction that under reasonable assumptions concerning population growth, war, G.N.P., etc. the surplus problem would still be with us in 1965. These supply estimates appear rather good. A related econometric model by William Cromarty divided the U. S. farm economy into 12 sectors. Predictions for each of the 12 sectors were aggregated into national indexes of output, input, prices paid and prices received. Though price elasticities of supply ranging from 0.37 in the case of beef to 0.678 in the case of broilers were secured for 13 different product categories,[4] not much significance should be attached to them as they are but part of an overall analysis aimed at producing estimates of aggregates. Cromarty's analysis is an annual one as contrasted to the Black-

[3] Glenn L. Johnson, "Supply Function—Some Facts and Notions," *Agricultural Adjustment Problems in a Growing Economy,* E. O. Heady, H. G. Diesslin, H. R. Jensen and G. L. Johnson, Eds., Iowa State College Press, Ames, 1958, p. 74.

[4] James T. Bonnen and William A. Cromarty, "The Structure of Agriculture," *Agricultural Adjustment Problems in a Growing Economy,* pp. 109f. The details of Cromarty's work are reported in *Economic Structure in American Agriculture,* Mich. State Univ. unpub. Ph.D. thesis, 1957.

Bonnen longer-run model. Both the Black-Bonnen and Cromarty efforts were hampered by the lack of data on resource use by individual commodities.

Most summaries of supply work fail to mention the work of personnel in the old BAE, ARS and AMS on supply. Time after time, commodity and aggregative supply response estimates have been needed in advising legislators, administrators and in connection with the outlook program. The moderate success of personnel from these agencies attests to the advantages of building up estimates from what is known about productive possibilities as determined by available technologies and the possibilities of acquiring or disposing of resources.

In the volume reporting the Black-Bonnen and the Cromarty models, your speaker advanced some ideas about asset fixity and the flow of resources into agriculture. These ideas produced 72 hypotheses about the flows of nine resource categories into, out of, and within agriculture under falling and rising product prices at four different stages in the business cycle. Examination of data on resource flows indicated that these hypotheses were in general accord with actual flows.[5]

At a later date Hathaway investigated resource flows at different stages in the business cycle and concluded that they were responsive to prices at all stages in the business cycle.[6] In the same article, Hathaway reported estimates of capital gains and losses due to price changes, by years, 1910 to 1956. Gains and losses will play an important role in ideas to be developed later in this paper as losses are a source of capital rationing and gains a means of overcoming capital rationing.

The interest of T. W. Schultz[7] in ratios between incremental outputs has caused your speaker to investigate economic adjustments (specialization and diversification) as a possible explanation of such ratios being greater than one. This investigation indicates (1) that such adjustments can explain such ratios theoretically and (2) that three types of specialization have, in fact, been important in American agriculture, namely, farm-nonfarm, geographic within agriculture and among farms.[8]

Following techniques employed by Johnson and Hathaway in burley tobacco and dry bean studies to be considered later, Stallings has developed measures of the influence of weather on the major indices of

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[5] Despite a regrettable mistake in which undeflated data were published as being in terms of 1910-14 dollars. See Glenn L. Johnson, *op. cit.*, Table 5.2, pp. 84-8.

[6] Dale E. Hathaway, "Agriculture and the Business Cycle," *Policy for Commercial Agriculture—its Relation to Economic Growth and Stability*, Joint Economic Committee, 85th Congress of the U.S., Nov. 22, 1957, pp. 51f.

[7] *Op. cit.*

[8] Glenn L. Johnson, "Sources of Expanded Agricultural Production," *Policy for Commercial Agriculture—its Relation to Economic Growth and Stability*, Joint Economic Committee, 85th Congress of the U.S., Nov. 22, 1957, pp. 127f.

aggregate U.S. farm output.[9] These indices are based on experiment station plot yields and are relatively free of the influence of economic adjustments and technological advance. As such, they are proving useful in aggregative analyses being carried out at the University of Chicago and Michigan State University.

Commodity supply responses

In his recent book, Marc Nerlove summarized some of the work done in the past on individual commodities.[10] His summary was limited primarily to the output of University of Chicago and U.S.D.A. workers. From his summary, Nerlove concluded that most empirical work indicates lower price elasticities of supply than encountered in the administration of production control programs. In drawing this conclusion, he did not distinguish between expansion and contraction elasticities. Nerlove concluded that inappropriate handling of price expectations and production adjustment possibilities was responsible for the low estimates. He attempted to remedy this by using distributed lags to estimate supply responses for corn, wheat, and cotton. Higher elasticities can result from the use of distributed lags as a consequence of the greater stability of means than of individual observations; thus, the higher elasticities obtained by Nerlove do not necessarily indicate a superiority, from a theoretical standpoint, of his estimates over earlier ones. As Nerlove's book is entitled *The Dynamics of Supply,* it is important to point out that its dynamicism is limited to the application of distributed lags to estimating coefficients of price expectations and adjustments.

Among supply response work not summarized by Nerlove is that of Black and Mighell on supply responses for milk in the Lake and New England States.[11] They based their supply response estimates on budgets for operating units actually producing milk in the two areas involved. This approach permitted them to handle asset fixity and prospective changes in structures[12] fairly adequately but on an *ad hoc* basis. While the Black-Mighell effort can be criticized for inadequacies with respect to dynamics and for failure to recognize the solution of the identification problems in discussing the estimation of "historical" (statistical and/or econometric) supply functions, their results proved moderately accurate in predicting responses over a ten year period. This work, at the individual commodity

[9] James L. Stallings, "Weather Indexes," *J. Farm Econ.*, 42:180, Feb. 1960.

[10] Marc Nerlove, *The Dynamics of Supply—Estimation of Farmers Response to Price,* The Johns Hopkins Press, Baltimore, 1958, pp. 21-25 and 66-86.

[11] Ronald L. Mighell and John D. Black, *Interregional Competition in Agriculture with Special Reference to Dairy Farming in the Lake States and New England,* Harvard University Press, Cambridge, Mass., 1951.

[12] *Ibid.*, pp. 59f.

level, is similar to that of Black and Bonnen at the macro level in that it is an *ad hoc* analysis of more relevant facts (including those pertaining to fixed conditions and assets) about supply than are commonly considered in more sophisticated statistical and mathematical analyses.

Recently, a number of attempts have been made to utilize Leontief input-output studies and programming to predict area- and industry-wide supply responses. To date these studies appear to be mainly of methodological interest.

Halvorson produced a study of milk supply responses to price in which he fitted separate supply functions for rising and falling prices,[13] a finding quite consistent with my own ideas about asset fixity and resource flows and with the findings of Mighell and Black.

Several people, including Friedman in general economics and Ciriacy-Wantrup in agricultural economics, have drawn attention to the distinction between positive and normative supply functions. More recently, the distinction has become such that *accurate* supply functions are labelled positive with normative being a somewhat derogatory epitaph reserved for *inaccurate* supply functions. This unfortunate distinction implies that the behavior of producers can be accurately predicted without reference to normative considerations and that inaccuracy would result from considering liquidity preferences, desires for security as reflected in risk discounts and desires for income to keep up with rising urban standards of living and wage rates.[14]

One of the more serious difficulties faced by the commodity supply analyst is the lack of data on the amounts of different resources used in the production of each farm product. Lack of such data requires researchers to deal with price-output rather than with production function relationships, thus limiting their alternative approaches.

Boyne and Johnson produced a note from the Interstate Managerial Study which has some significance for supply response work.[15] With respect to both farm organization and responses to changes in product and factor prices, asset fixities were found to play roles not accounted for in systems of economic analyses which regard acquisition costs as equal to salvage values for productive factors.

Cochrane and Wilcox have pointed out the role which opportunity

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[13] H. W. Halvorson, "The Supply Elasticity for Milk in the Short Run," *J. Farm Econ.*, 37:1186, Dec. 1955.

[14] This subject is more adequately developed by Glenn L. Johnson, "Values in Farm Management," presented at the Harrogate meeting of the Agricultural Economics Society, December, 1959 and to be printed in *Journal of Agricultural Economics*, Vol. 14, Dec. 1959.

[15] David H. Boyne and Glenn Johnson, "A Partial Evaluation of Static Theory from Results of the Interstate Managerial Study," *J. Farm Econ.*, 40:458, May 1958.

costs play in explaining the flow of resources fixed for farms (individually and for the farm sector) among the different commodities.[16]

Summary and conclusions about past work

While the above summary of supply studies is incomplete (space does not permit a more extended survey) it does provide a basis for concluding that:

(1) Commodity supply response studies have been relatively more successful than supply response studies for the entire agricultural industry.

(2) Asset fixities (including both imposition and relaxation) have conditioned both commodity and total agricultural supply responses.

(3) Opportunity costs account for the allocation of resources which are fixed in agricultural production among different products and, hence, permit greater success in using Marshallian supply concepts to estimate responses for individual commodities than for the entire farm economy.

(4) *Ad hoc* handling of asset fixities by personnel in the old BAE, AMS and ARS, and by Mighell, Black, Bonnen, and Schuh provides evidence that supply response estimates can be improved by taking asset fixities into account. Hathaway's and Johnson's hypotheses and data on resource flows, the meagre Boyne-Johnson investigation of decision making and Halvorson's higher elasticities for rising than for falling prices all indicate that it is quantitatively quite important for supply analyses to predict within themselves (endogenously) when different kinds of resource flows do and do not take place within agriculture and between the farm and nonfarm economy. This applies to both commodity and farm sector analyses.

(5) The fair success enjoyed by analysts who have modified the usual Marshallian supply analysis to take into account external (exogenous) changes in technology, business cycles, institutions, populaton, education, and standards of living requires a continuation of attempts to incorporate measures of such variables in supply analyses.

(6) The managerial process within which farmers identify, solve and adjust to production, income and/or price problems has been neglected though a few scattered works such as D. Gale Johnson's on forward prices, the three analyses of control programs mentioned above and the IMS have established the importance from the standpoint of studying supply responses of developing a better understanding of the managerial process.

(7) Leontief input-output studies and area-wide programming are subject to the shortcomings implied above.

[16] Willard W. Cochrane and Walter W. Wilcox, *Economics of American Agriculture,* Prentice-Hall, Inc., New York, 1951.

(8) Large scale capital gains and losses are received by farmers which (1) affect their ability to expand and contract production and (2) may be confused with income-producing capacity of inputs.

Some Suggestions for Improving Agricultural Supply Analysis

Possibilities for improving supply analysis range *from* improving the measures of resource flows (including technology and improvements in the human agent) *through* the use of improved statistical and mathematical techniques and better static economic theories *to* developing highly dynamic models placing heavy emphasis on the decision making process. In what follows, I will attempt to suggest some improvements and extensions of the usual neo-classical static marginal theory of production, costs and supply. While my dissatisfaction with the current theories of the firm, costs and supply responses is deep, I should point out that I do not propose their demise; instead I propose only a modest transfusion of more realistic price assumptions to strengthen these theories for purposes of supply analysis. I leave the still more complex problems of dynamics for another time and, most likely, for more capable intellects working from the richer background of experience which the future will probably provide.

Acquisition costs and salvage values for farm inputs

The farm firm, whether specialized or diversified, typically faces two prices for its inputs—one when it acquires and another when it sells them. This is true for farm produced durables such as breeding stock, fruit trees, and pasture stands; for nonfarm durables such as tractors and bulk tanks for milk; for much of the U.S. farm labor force; and for such farm produced expendables as feed grains, hay, pastures and seeds. Even a stock of nonfarm durables, such as fuel or commercial fertilizer, costs more delivered to the farm than can be *netted* for it if, later in the time consuming growth processes so typical of agriculture, it proves necessary to place it on the market. Farms are dispersed geographically from each other and from their factor and product markets. Further, their production processes are typically very time consuming. Crop production is generally an annual affair. Livestock production processes range from a few weeks to years for some qualities of beef while it may take up to 20 years to bring some fruit trees into full production.

In agriculture, off-farm acquisition costs for factors of production typically exceed off-farm salvage values. Within farms, the same is often true between enterprises, though the proximity of enterprises and the absence of "selling costs" substantially reduce the difference between acquisition costs and salvage values which exists for off-farm transactions. The large

number of firms in American agriculture and widespread farm-by-farm and geographic specialization require important off-farm transactions before *major* expansions and contractions can occur for such important products as milk, wheat, western feeder steers, cotton, fruit, and pork.

Acquisition costs and salvage values in theory

Differences between acquisition costs and salvage values are handled by various devices in theories of the firm, costs and supply functions. These devices vary from theorist to theorist and typically fail to handle the entire problem. In fact, it appears doubtful whether the combined writings of the classicists, neo-classicists, and modern writers handle all parts of the problem even on a piece-meal basis. Some of the parts have been discussed under such sub-headings as quasi-rents; opportunity costs; user costs; short, intermediate and long run supply responses; and partial equilibrium responses.

Marshall, for instance, uses the quasi-rent concept and three lengths of run but does not (1) refer to opportunity costs or user costs in his index or (2) explain how the analyst is to know when to shift among the short, intermediate and long runs when analyzing supply response problems.

Stigler has discussed the possibility of positive as well as negative quasi-rents.[17] While preferring to define quasi-rents with respect to salvage values (which makes them positive), he dislikes Marshall's method which employs acquisition costs (mostly historic) which may result in negative quasi-rents. Stigler, however, does not develop a more general system employing *both* acquisition costs and salvage values as they affect marginal costs and supply responses.

Keynes develops the concept of user cost[18] to include "the sacrifice which 'an employer' incurs by employing the equipment instead of leaving it idle. This is related to acquisition costs for the *services* of the equipment and to both its salvage value and acquisition cost. A. W. Lewis extends and clarifies the user cost idea[19] by stating that "The immediately escapable cost is user cost" which is in turn the larger of three cost figures one of which includes the scrap or salvage value of the durable generating the service in question. Unfortunately, Lewis does not consider acquisition costs for the durable. Had he considered them as well, he might have isolated the relationships among salvage values, acquisition costs,

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[17] George Stigler, *The Theory of Price*, The Macmillan Company, New York, 1949, pp. 179f., especially the second footnote p. 180.

[18] J. M. Keynes, *The General Theory of Employment, Interest and Capital*, Macmillan and Co., London, 1942, p. 23; also see p. 53 and the appendix starting on p. 66.

[19] A. W. Lewis, *Overhead Costs—Some Essays in Economic Analysis*, George Allen and Unwin, London and Working, 1949, p. 10, n. 1.

asset fixity or variability, length of run, marginal costs and supply functions.

Weintraub[20] in a chapter entitled "Rent and Quasi-rent" considers asset fixity and the distribution of income to the owners of fixed assets. In defining fixity at the *firm level* Weintraub states that "so long as firms estimate that a further unit of an agent would not be profitable, then the factor is effectively fixed."[21] Weintraub had his hands on acquisition costs while Stigler, Keynes, Lewis and others dealt with salvage values. Unfortunately, Weintraub did not put the two together to produce a more complete explanation of asset fixity, shifting marginal costs and shifting supply functions.

In agricultural economics, J. D. Black has given much attention to opportunity costs as an aspect of comparative advantage but little theoretical attention to the question of fixity and its influence on marginal costs and supply responses.[22] Boulding, who has contributed importantly to the theoretical training of agricultural economists, has not handled quasi-rents, opportunity cost or asset fixity in an organized manner. Neither has Heady, one of Boulding's most prominent students.[23]

The recent interest in linear programming has involved opportunity costs, as linear programming applies the opportunity cost principle to determine the optimum allocation of a set of fixed resources among a set of alternative uses.[24] Though most linear programs to date have not involved endogenous determination of the "best" set of "fixed" resources,[25] programming has rekindled interest in opportunity costs. Again, however, it must be observed that linear programmers have not yet produced an overall analysis of opportunity costs, salvage values and acquisition costs as they bear on the supply responses for firms, commodities and economic sectors such as agriculture.

Samuelson writes,[26] "the usual formation" of opportunity costs "is rather a mumbo jumbo of high sounding gibberish, which does not state the conditions of equilibrium in a very direct way . . . when the opportun-

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[20] Sydney Weintraub, *An Approach to the Theory of Income Distribution,* Chilton Co., Philadelphia, 1958.

[21] *Ibid.,* p. 170.

[22] See above for his *ad hoc* handling of these problems, however. Also see Mighell and Black, *op. cit.,* pp. 59f.

[23] See Kenneth Boulding, *Economic Analysis,* Harper and Brothers, New York, 1941 and Earl O. Heady, *Economics of Agricultural Production and Resource Use,* Prentice-Hall Inc., 1952.

[24] Robert Dorfman, Paul A. Samuelson and Robert U. Solow, *Linear Programming and Economic Analysis,* McGraw Hill Book Co., 1958, Chap. 7, "Application to the Firm: Valuation and Duality."

[25] See below for a discussion of important exceptions.

[26] Paul Samuelson, *Foundations of Economic Analysis,* Harvard Univ. Press, Cambridge, Mass., 1953, p. 234, footnote 32. *(Italicization added.)*

ity cost doctrine is carefully stated and qualified, it degenerates into the full conditions of general equilibrium in which *factor supply and preference* equations must be introduced. . . ." One can only wish that Samuelson had worked out a general equilibrium system involving acquisition and salvage prices (with appropriate premiums and discounts for preferences) as they affect supply responses at the individual firm and industry levels.

While quoting Samuelson it is also worthwhile quoting him on the elasticity of supply. He writes,[27] "Through the influence of Alfred Marshall economists have developed a fondness for certain dimensionless expressions called elasticity coefficients. On the whole it appears that their importance is not very great except possibly as mental exercise for beginning students." In a footnote he elaborates further. "There is perhaps some usefulness of the concept of elasticity of demand as giving an indication of the qualitative behavior of total revenue, but even this is only a consequence of neglecting to deal with total revenue directly." On the next page[28] he writes, "Not only are elasticity expressions more or less useless, but in more complicated systems, they become an actual nuisance. . . ." Before this paper is complete, it will be clear that the failure of agricultural economists to produce many reliable estimates of the price elasticity of supply is not the tragedy some persons (obviously not Samuelson) think it is.

A suggested improvement

Let us start off with a production function for a single firm producing Y with two inputs X_1 and X_3. Let X_1 be a one-use input and, hence, a flow or service while X_3 is the service of a durable. Let there be a one-to-one relationship between the flow or service and stock of X_3. Assume that

$$P_{X_3}\,\text{acq} > \frac{\partial Y}{\partial X_3} P_Y > P_{X_3}\,\text{salv}$$

for the quantities of X_1 and X_3 on hand as well as for any price of Y to be considered and any amount of X_1 it may prove possible to use with X_3. Under these drastic assumptions, X_3 is fixed for the entire range of possibilities to be considered. Its fixity justifies the assumption that $Y = f(X_1 \mid X_3 = a)$ conforms to the law of diminishing returns. As

$$P_{X_1}\,\text{acq} > P_{X_1}\,\text{salv},$$

the amount of X_1 on hand, which is a in Figure 1, is fixed under some conditions but variable under others.

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[27] Samuelson, *op. cit.*, p. 123.
[28] Samuelson, *op. cit.*, p. 124.

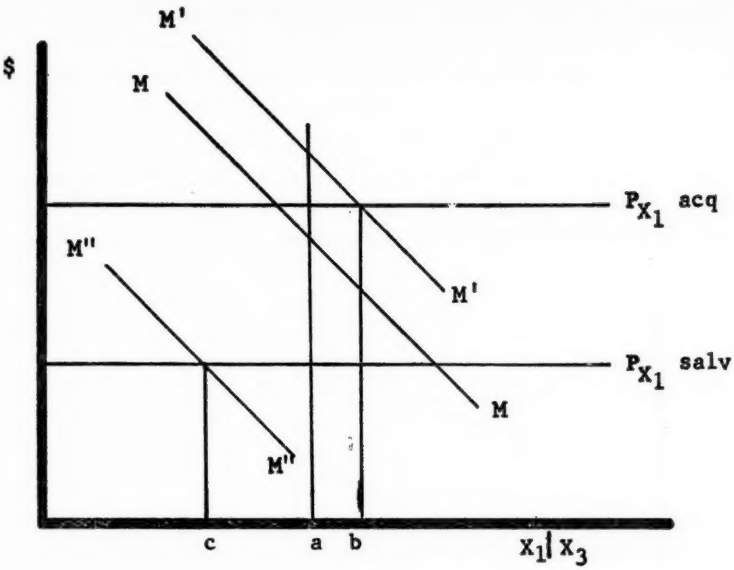

Figure 1

If

$$\frac{\partial Y}{\partial X_1} P_Y \text{ is } MM,$$

X_1 is fixed at *a*. If, however, P_Y increases so that

$$\frac{\partial Y}{\partial X_1} P_Y \text{ shifts to } M'M',$$

the marginal value productivity of X_1 exceeds its acquisition price and the most profitable amount of X_1 to use expands to *b*.

Conversely a fall in P_Y which drops $\dfrac{\partial Y}{\partial X_1} P_Y$ to $M''M''$ would reduce the most profitable use to *c*.

If P_Y were varied continuously, no change in the use of X_1 from a would occur until the following condition is violated:

$$P_{X_1} \text{ acq} \geq \frac{\partial Y}{\partial X_1} P_Y \geq P_{X_1} \text{ salv}.$$

This condition, then, is the definition of a fixed, one-use asset.

The marginal cost of producing Y, MC_Y, has a discontinuity at $Y = f(a \mid X_3)$. Beyond this point

$$MC_Y = P_{X^1} \text{ acq} \Big/ \frac{\partial Y}{\partial X_1}$$

For quantities of $Y < f(a|X_3)$, MC is lower than for $Y = f(a|X_3)$ as in Figure 2.

The discontinuous marginal cost curve in Figure 2 has the further interesting property of a shifting discontinuity. For instance, if b of X_1 were acquired, the discontinuity would follow the dotted line onq rather than the solid line opq. In the original case, as P_Y increases from o to p, quasi-rents figured with respect to salvage value become more and more positive, but less and less negative with respect to acquisition costs.

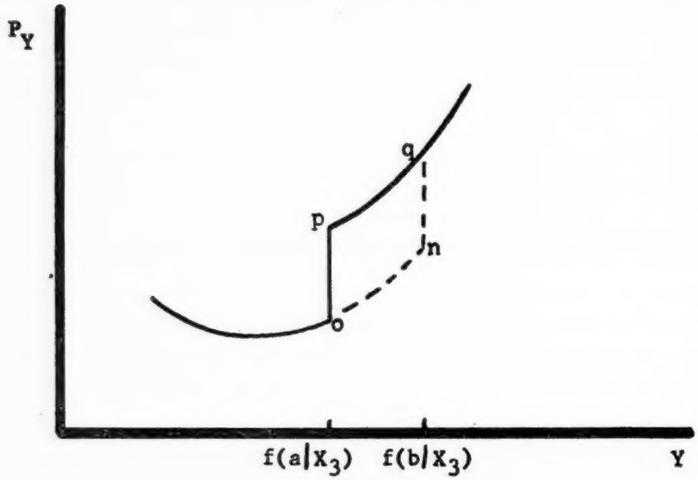

FIGURE 2

While there are many interesting properties of this model worth investigating further (such as quasi-rents for X_3 and capital gains and losses for both X_1 and X_3) more important insights can be gained by expanding our analysis to include X_2.

This three-factor problem involves the production function

$$Y = f(X_1, X_2 | X_3 = a)$$

which, by the fixity of X_3, conforms to the law of diminishing returns. The function can be drawn as in Figure 3 which assumes it to be of the form.

$$Y = AX_1^{b_1}X_2^{b_2} \quad \text{where} \quad A = aX_3^{b_3} \quad \text{and} \quad \sum_{i=1}^{3} b_i = 1.$$

Other forms could be used without destroying the conclusion reached herein; indeed, the only reason for using any specific form is to make figure construction a little more definite.

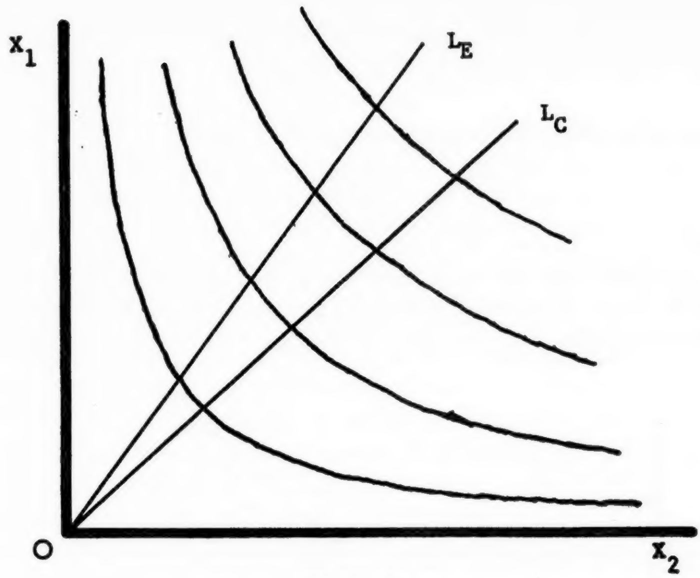

FIGURE 3

If

$$\frac{P_{X_1}\,\text{acq}}{P_{X_2}\,\text{acq}} < \frac{P_{X_1}\,\text{salv}}{P_{X_2}\,\text{salv}},$$

the line of least cost combinations of X_1 and X_2 for *increases in the price of* Y will be different than the line of least cost combination for *decreases in the price of* Y, the two lines being OL_E and OL_C, respectively. The interesting question arises about how the profit maximizing firm would move from OL_E to OL_C following periods of expansion in production. The answer is that it moves straight downward but not until after P_Y has fallen enough for

$$\frac{\partial Y}{\partial X_1} P_Y < P_{X_1}\,\text{salv}$$

Further decreases in P_Y eventually result in

$$\frac{\partial Y}{\partial X_2} P_Y < P_{X_2}\,\text{salv}$$

and the contraction of both inputs along OL_C. A reversal of the downward movement in P_Y would reverse this process; initial increases in P_Y would not increase production but eventually

$$\frac{\partial Y}{\partial X_1} P_Y > P_{X_1}\,\text{acq}$$

to be followed by

$$\frac{\partial Y}{\partial X_2} P_Y > P_{X_2}\,\text{acq}$$

and expansion along OL_E or some other OL_E in case

$$\frac{P_{X_1}\,\text{acq}}{P_{X_2}\,\text{acq}}$$

changes.

The marginal cost functions associated with such movements in P_Y are enough to cause economics professors for sophomores to tremble in fear that the knowledge whereby they earn their daily bread (who among us

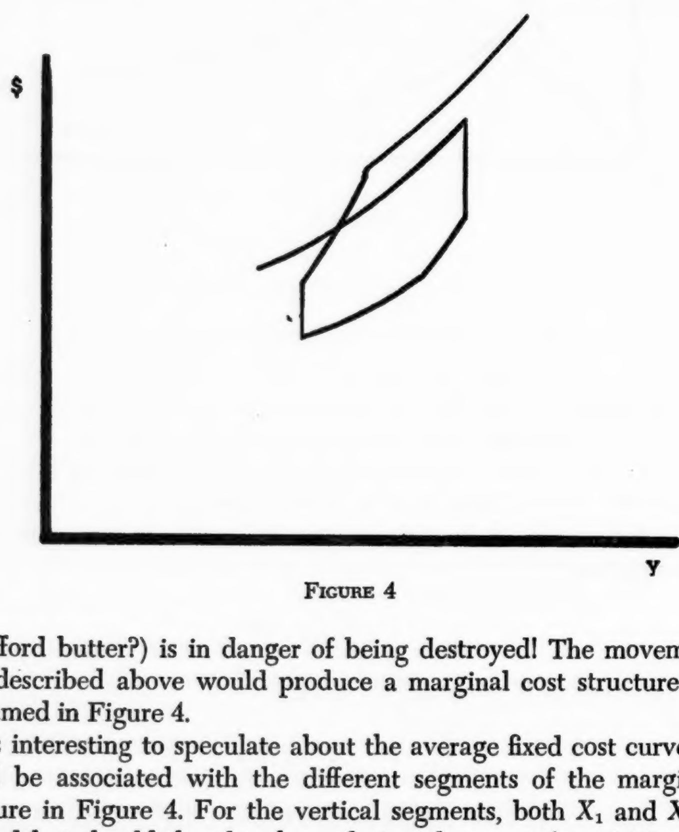

FIGURE 4

can afford butter?) is in danger of being destroyed! The movements we have described above would produce a marginal cost structure such as diagramed in Figure 4.

It is interesting to speculate about the average fixed cost curves which would be associated with the different segments of the marginal cost structure in Figure 4. For the vertical segments, both X_1 and X_2 would be fixed but should they be charged at replacement (acquisition) cost or market (salvage) value? And what about P_{X_3} in figuring fixed costs? Do we use its acquisition or salvage price? And, do we consider quasi-rents? And, how do we handle the sections derived from

$$Y = AX_1^{b_1}/X_2^{b_2}$$

when X_2, as well as X_3, is fixed? Interesting as these questions are, however, they should not be permitted to distract us from supply response questions.

Aggregation of movements within such marginal cost structures should produce commodity supply functions which display discontinuities and different elasticities for expansions than for contractions; these in turn raise very real questions about the value of elasticity estimates for supply over and beyond those, previously mentioned, raised by Samuelson. Still further, such an aggregative analysis would be capable of explaining endogenously the shifts from one segment of the structure to another.

If marginal cost structures for firms exhibit discontinuities with different slopes for contractions than for expansions in output, the yearning of economists for price elasticities of supply seems a little misplaced. What we seem to need is estimates of changes in quantities with respect to price under changing conditions. This is, of course, in addition to Samuelson's reservations about the usefulness of elasticity expressions.

Before moving to additional inputs, it is interesting to consider four iso-marginal value product lines in the function

$$Y = AX_1^{b_1}X_2^{b_2},$$

two for X_1 and two for X_2. For each of these inputs, we are interested in the locus of all points

$$\frac{\partial Y}{\partial X_i} P_Y = P_{X_i}\,\text{acq} \quad \text{and} \quad \frac{\partial Y}{\partial X_i} P_Y = P_{X_i}\,\text{salv}.$$

These four iso-marginal value product lines are presented in Figure 5 as solid lines.

These four lines divide this particular sub-production function into nine areas. The expansion line OL_E of Figure 3 passes through the high profit point (HPP) in the lower left hand corner of area 5. The contraction line goes through its upper right hand corner.

When the firm is organized in area 5, X_1, X_2 and X_3 are all fixed factors of production. If organized in area 7, both X_1 and X_2 can be contracted. In area 8, only X_2 can be contracted. In area 4, only X_1 can be contracted. In area 1, X_2 can be expanded and X_1 can be contracted, the reverse being true in area 9. In areas 2 and 6, *mainly* expansions in one but not in the other are possible, the situations being different on the borders. In area 3, both X_1 and X_2 can be expanded. The rectangle defined by *a, o, b* and *HPP* represents organizations producing less than the optimum output which can be revised to reach the optimum at *HPP*. All other organizations producing less than the output represented by the iso-product line passing through *HPP* cannot be revised, without selling an input whose value in its present use exceeds its salvage value, so as to reach the *HPP:*

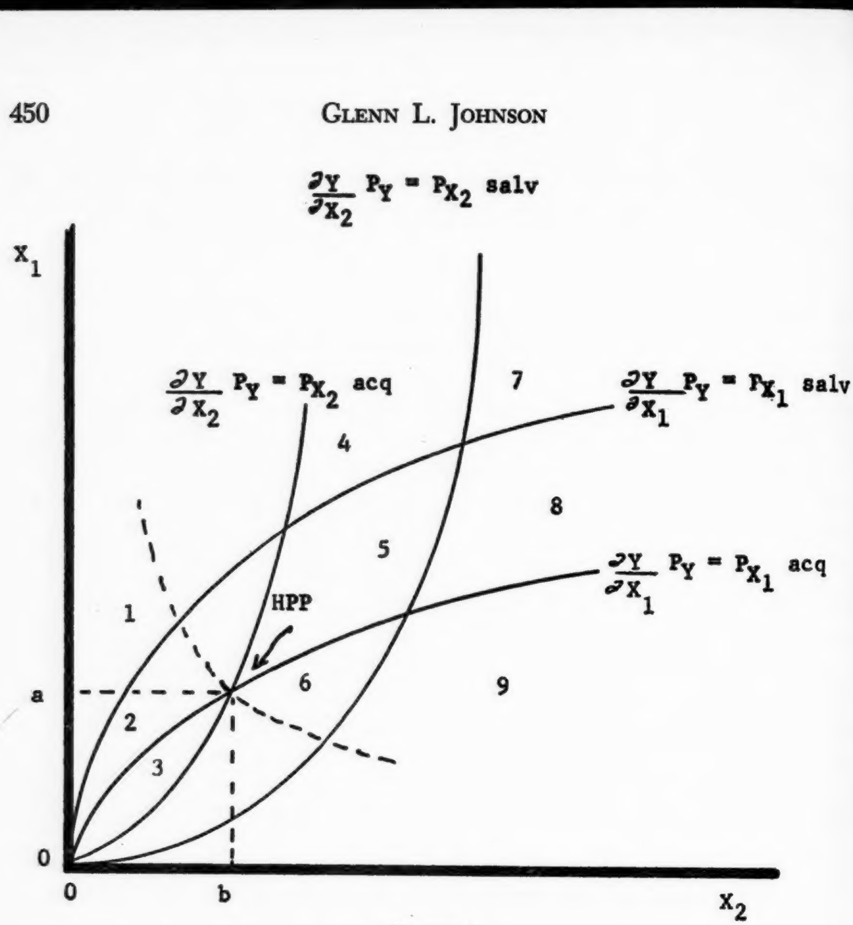

FIGURE 5

maximizing profits for such an organization involves *overproduction* relative to *HPP*.

Similarly, any organization producing more than the output at the *HPP* cannot maximize its profits and produce as little output as at *HPP*. All cases of overproduction result in capital loss relative to acquisition costs. These generalizations were more fully developed in a Heath Memorial Lecture[29] and in a paper given at the Manchester Statistical Society.[30] The explanation of overproduction and capital losses offered by this theory makes it consistent with the capital losses data reported by Hathaway[31] and the most outstanding characteristic of American agriculture,[32] its tendency to overproduce at unsatisfactory rates of return to labor and/or capital. In the next paragraph the receipt of capital gains and losses

[29] University of Nottingham, Sutton-Bonington, England, Oct. 13, 1959. To be printed in *Journal of Agricultural Economics*, June 1960.

[30] Glenn L. Johnson, "Some Basic Problems for Economists and Statisticians Arising from U. S. Agricultural Policies," *Transactions of the Manchester Statistical Society* session 1959-60, pp. 1f.

[31] D. E. Hathaway, "Agriculture and the Business Cycle," *op. cit.*

[32] Glenn L. Johnson. "Some Basic Problems . . .," *op. cit.*

will prove to determine what portions of marginal cost structures are relevant for individual firms.

More complicated analyses can be constructed involving any number of inputs without severe restrictions of the type placed on X_3 in the above description. Positively sloping credit supply functions, which are realistic, make both acquisition costs and salvage values positive functions of quantities used; these in turn produce optima even if the analysis makes all inputs at least partially variable on production functions displaying constant returns to scale. Clark Edwards has developed the theory of such responses in mathematical form at the firm level but has not investigated the problem of aggregating the resultant marginal cost functions into commodity supply functions.[33] In Edwards' theory and in reality, the availability of credit depends on net worth and net worth depends on capital gains and losses.

Less elegant formulations for firms producing more than one product have been developed by the author. These formulations have, in turn, been combined with Edwards' results and programmed (linearly) by Peter Hildebrand and Frank Dvorak.[34] Two problems encountered but not adequately handled by Hildebrand, Dvorak and, earlier, by Edwards include (1) indivisibilities of durables and (2) varying rates of resource flows from fixed durables. Both are likely to be important in supply response work.

Suggestions for Future Work

The following suggestions are designed to improve supply analysis by providing more appropriate static economic concepts and data. Still other suggestions would provide for more appropriate dynamic and, most likely, interdisciplinary concepts and data but cannot be included within the limits of this paper.[35]

1. Expand the theories discussed above to cover:
   (a) aggregation of marginal cost structures for firms into
      i. commodity and
      ii. sector supply response concepts

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[33] Clark Edwards, *Resource Fixity, Credit Availability and Agricultural Organization,* unpub. Ph.D. Thesis, Mich. State Univ., 1958 (abstract available on request). See also Clark Edwards, "Resource Fixity and Farm Organization," *J. Farm Econ.,* 41:747, Nov. 1959.

[34] Peter E. Hildebrand, *Farm Organizations and Resource Fixity: Modifications,* unpub. Ph.D. Thesis (mimeo available on request), Mich. State Univ., 1959, and Frank Dvorak, *Farm Organization and Capital Use for a Cash Crop Farm in the Saginaw Valley and Thumb Area of Michigan,* unpub. M.S. Thesis, Mich. State Univ., 1959 (abstract available on request).

[35] Alan Bird, at Michigan State University, under an Agricultural Research Service contract, is concentrating on the development of such concepts.

(b) the demand for and the supply of major resource categories by the producers of major commodities or commodity groups.

(c) In doing (a) and (b), place emphasis on concepts which permit the prediction of quantities, prices and changes in quantities and prices under defined conditions. Prediction of elasticities of supply promises to be of limited usefulness.

2. Carry out an aggressive program of data collection and compilation to provide measures of the resource flows which the theory developed under (1) above indicates to be important in determining supplies of important agricultural commodities. These categories will probably include hired labor; family labor; operator's labor; several categories of farm-produced durables and expendables; and publicly provided productive services; as well as several categories of non-farm-produced durables and expendables.
3. Carry out an aggressive program of data collection and compilation with respect to the current and historical net worth positions and credit opportunities open to producers of the main farm commodities. In this connection it will be important to handle capital gains and losses.
4. While waiting for the data called for in (2) and (3) above,

(a) present fairly adequate data on the entire farm economy should permit estimates of aggregative supply responses to be based on the more aggregative of the theories called for in (1) above. The success of efforts in U.S.D.A. and by Black, Bonnen, and Cromarty to build up aggregative estimates from commodity analyses suggests, however, that our best aggregative estimates will probably have to wait improved commodity estimates.

(b) Commodity studies utilizing the theories from (1) can be carried out for minor commodities produced by specialized farmers or produced with quite specialized resources long before adequate data are available for all of the major commodities or commodity sectors.

5. Present progress in handling such supply function shifters as technological advance, weather and improvements in the human agent should not be impeded in order to carry out (1) to (4) above, as these shifters are important in studying supply responses.

INTER-AREA RELATIONS IN AGRICULTURAL SUPPLY*

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GEOGRAPHICAL shifts in production have been pervasive and unceasing. Persons concerned with farm adjustments for a state or region need to take account of geographical shifts to keep in harmony with economic forces impinging on their area. At the national level the effectiveness of agricultural control programs is tempered by forces making for shifts, and the programs themselves have an influence on location of production to be considered in choosing between policy alternatives.

In the first part of the present paper, a conception is presented of regional interdependence for American agriculture. A device giving indications of crop expansions and substitutions is used to test the conception. In the second part of the paper, an approach is developed for estimating supply chains of reactions among regions. Major chains of reactions are estimated for two periods

Nature of Regional Interdependence in Agriculture

The following four characteristics suggest that geographical relations are important in tracing supply responses, and they provide guides for studying the geographical relations.

First, the agricultural regions of the United States are in competition with each other because they produce for a common market. Competition is made keen by inelasticity of national demand for agricultural products. Federal control programs may translate the price movement due to production changes into accumulation or decumulation of stocks. But, whether through price or storage, pressures are generated to bring production near consumption. International demand and foreign disposal programs do not alter the assertion that demand acts to control aggregate production, for foreign demand is not perfectly elastic. Demand is like a *container* to which supplies from various areas must accommodate themselves.

Secondly, the agricultural regions have crops in common with one another, i.e. there is in fact regional competition in supply. If each region produced a different crop, supply adjustments for one region might safely be considered separately from those of other regions. But because of some commonality in crops, what happens in one part of the county is not independent of what happens elsewhere.

A *third* characteristic is that the agricultural regions are different from each other. If every area were identical, results for one region might simply be multiplied by the number of regions to arrive at national figures. However, contrasts in comparative advantage due to climate, soil,

* This is Journal Paper No. 1119 of the North Carolina Experiment Station.

topography and population attributes mean that responses differ between areas. As a result, there is the possibility of having intricate sets of regional displacements associated with supply adjustments.

The second characteristic says that the regions are similar enough for some crops to be grown in more than one area, while the third characteristic says they are dissimilar enough to have different supply responses. This concatenation of similarity and dissimilarity leads to the hypothesis that supply adjustment entails "chains of reactions." Consider a technological change that favors the growing of cotton in the West. The West grows more cotton, and because of the demand container the South is forced to decrease cotton. Land may go out of production in the South, but the region also turns to cotton's next best alternatives, perhaps principally livestock. Then the Midwest may be forced away from livestock production into wheat. And so on. This example of a chain of reactions suggests how mechanization and irrigation favoring cotton in the West can roundaboutly add to wheat surpluses, and perhaps an end result is to force some Great Plains wheat farmers out of business.

Let us consider a *fourth* characteristic of agriculture: Supply and demand shocks are continually occurring that favor different areas differently. The shocks are initiators of chains of reactions. Shocks on the supply side may include mechanization, irrigation and fertilization. Growth of cities is a shock affecting agricultural supply. Government land development, such as reclamation and agricultural flood protection, is supply-affecting. Federal crop acreage restrictions can act as supply shocks, inducing farmers to increase plantings of alternative crops that affect other regions. On the demand side, the most dramatic shocks have been expansions and contractions of total demand for agricultural products accompanying wars and following them. A relative change in demand is the secular shift toward consumption of livestock products. Changes in foreign supply and in foreign trade policies can be shocks to the demand for U.S. production.

The four characteristics that have been noted add up to a conception of regional interdependency where supply adjustments are capable of ramifying in chains through the whole of agriculture. Shocks impart a continuing tendency for these ramifications to take place.

Changes in corn acreage from 1949 to 1954 provide a preliminary test of the conception. For the United States during this period there was a corn acreage decline of 5.2 million acres. Contributing to the overall decline were:

a) increases in yields, which meant that demand for corn could be met with fewer acres,
b) adjustment downward from the war-expanded production levels of 1949,

c) substitution of sorghum for corn in some of the Central states, and
d) decline in demand for corn for workstock, especially in the South.

Table 1 shows the results of considering changes in corn acreage for State Economic Areas. The declines in the South Atlantic, East South Central and West South Central appear to have been associated in part with substitution of tractors for work animals. To this extent they represent disturbances that act to initiate supply adjustments, just like the rest of the factors listed above.

However, the declines in corn acreage in the South were associated partly with a general decline in agriculture in that region. To this extent the declines represent the *end* rather than the beginning of chains of reactions. A hypothesis about the declining agriculture of the South is as follows: The combination of an over-expanded agricultural plant for the country as a whole, plus technological changes surrounding mechanization that have cost-wise favored other regions, is leading to decline in the South. The South contains many marginal areas that have difficulty finding profitable alternatives. This is clearly demonstrated in those areas that have contracted due to shortage of croppers.[1] Chains of reactions may often ramify until they reach marginal areas and so finally end in a contraction or expansion of agriculture in those areas.

Consider now the areas in Table 1 where corn acreage expanded. These were concentrated in the North Central States, even though some areas in these states had corn acreage declines. How can we account for the expansions in view of the overall decline in corn? One hypothesis is that there were expansions in some areas in response to the drastic cut in wheat acreage between 1949 and 1954. That is, there may have been substitution of corn for wheat. This imposed greater contraction for corn on the rest of the country than might otherwise have been necessary. The totals in Table 1 indicate that there were increases of corn of 2.4 million acres in some Economic Areas, so the net U. S. figure was achieved through a 7.6 million acre decline in corn for the other Economic Areas.

The corn acreage expansions appear to be in the middle of chains of reactions. Suppose we were drawing arrows to trace direction of causality. We would draw an arrow from wheat to corn for the Economic Areas which expanded corn in the North Central States. *Then* we would draw an arrow coming out of corn in these latter areas to Economic Areas that showed corn acreage declines.

Another way to test the conception of regional interdependency is to consider measures of expansion and substitution. If adjustments in an area were entirely substitutions, there would be both acreage increases and decreases—with the sum of the increases just equalling the sum of

[1] Several recent studies in different parts of the South have indicated that land is going idle because croppers have migrated and replacements have not been found.

TABLE 1. CORN ACREAGE CHANGES, 1949–54[a]

State	Sum of Economic Area Increases	Sum of Economic Area Decreases
Northeast		
Maine	1,311	0
New Hampshire	262	0
Vermont	7,524	0
Massachusetts	1,045	− 3,083
Rhode Island	0	− 851
Connecticut	1,577	− 1,833
North Atlantic		
New York	102,989	− 11,073
New Jersey	26,275	0
Pennsylvania	35,528	− 20,409
East North Central		
Ohio	118,278	− 17,187
Indiana	164,300	− 19,541
Illinois	385,529	− 470,913
Michigan	302,022	− 16,392
Wisconsin	22,964	− 62,609
West North Central		
Minnesota	942	− 333,008
Iowa	0	− 983,796
Missouri	293,641	− 129,110
North Dakota	124,791	− 75,923
South Dakota	205,958	− 267,438
Nebraska	41,497	− 753,728
Kansas	36,165	− 366,017
South Atlantic		
Delaware	41,364	0
Maryland	56,087	− 5,837
Virginia	12,508	− 99,719
West Virginia	5,176	− 51,510
North Carolina	82,683	− 179,756
South Carolina	0	− 315,683
Georgia	51,245	− 278,586
Florida	12,010	− 8,453
East South Central		
Kentucky	0	− 252,153
Tennessee	30,747	− 271,665
Alabama	62,909	− 262,358
Mississippi	1,102	− 354,426
West South Central		
Arkansas	0	− 417,553
Louisiana	0	− 104,575
Oklahoma	0	− 764,140
Texas	25,431	− 474,246
Mountain		
Montana	23,839	0
Idaho	20,203	− 1
Wyoming	8,744	− 95
Colorado	3,124	− 215,422
New Mexico	0	− 44,845
Arizona	6,690	− 8,766
Utah	6,427	0
Nevada	858	0
Pacific		
Washington	16,897	− 1,996
Oregon	7,448	− 3,869
California[b]	83,057	—
Totals	2,431,147	−7,648,565

(Footnotes on page 457)

the decreases. Expansions or contractions are indicated by a difference in the two sums.

For each State Economic Area, take the four most important crops when ranked according to acreage and lump the rest of the harvested acres into an "other" category. Group the five crops (the four most important plus "other") into those whose acreage increased between 1949 and 1954 and those whose acreage decreased. Now consider three magnitudes: (1) sum of the acreage increases, (2) sum of the acreage decreases and (3) difference between the two sums. The larger of the sums is suggestive of the total amount of supply adjustment, since at least that many acres must have changed use. The difference between the two sums is the net change in harvested acreage, i.e. the measure of expansion (or contraction). The remainder of the total adjustment—that is, the sum of the acreage increases or the sum of the decreases, *whichever is smaller*—gives a measure of crop substitution in the area.

From 1949 to 1954, there was a decline of about 11 million harvested acres for the United States. Table 2 gives an idea of total adjustment going on behind this change. The indications of substitutions within State Economic Areas total to more than 27 million acres. The net change for those areas showing contraction was a decline of over 17 million acres, and the net change for areas of expansion was over 6 million acres. These figures thus reveal over 50 million acres involved in supply adjustments, forceful support for the idea that there were substantial shocks for agriculture during this period.

New England reveals universal contraction with little substitution, reflecting urban encroachment and a secular disadvantage in agriculture in evidence for several decades. The East North Central and the West North Central states have comparatively little *net* change for the most part, in comparison with large adjustments at the Economic Area level. In particular, the huge substitutions for many of these states which at the same time have little net change in acreage suggest that this section of the country is prone to be in the middle of chains of reactions. It tends not to be marginal agriculturally (a notion reinforced by noting its relatively high land values), so that residual equilibration for agriculture as a whole may most often be left to other regions. The role of the South as a marginal area has already been suggested. This is in line with the fact that the South presents a mixed picture with decline of agriculture but also with

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[a] Source: U. S. Bureau of the Census, *Counties and State Economic Areas, United States Census of Agriculture: 1954*, Vol. I (Washington: Govt. Print. Off., 1956), Economic Area Table 3 for each state. Since the data are based on a 20 per cent sample of farms, totals shown above for changes in state and U. S. harvested acreage will not agree exactly with summary census tables based on complete enumeration.

[b] California is the only state for which corn acreage was not given by economic area. To complete the table, net change in corn for the state has been entered with no available measure of any offsetting decreases.

TABLE 2. INDICATIONS OF CROP EXPANSION, CONTRACTION AND SUBSTITUTION, 1949–54[a]

State	Net Change in Harvested Acreage	Analysis of Change for State Economic Areas: Sum of Area Expansions	Sum of Area Contractions	Indications of Substitution Within Areas
New England				
Maine	− 133,345	0	− 133,345	8,819
New Hampshire	− 37,751	0	− 37,751	262
Vermont	− 42,703	0	− 42,703	9,242
Massachusetts	− 39,126	0	− 39,126	1,686
Rhode Island	− 14,941	0	− 14,941	0
Connecticut	− 33,027	0	− 33,027	1,577
Middle Atlantic				
New York	− 254,204	+ 21,368	− 275,572	128,963
New Jersey	204	+ 3,146	− 2,942	38,640
Pennsylvania	− 209,089	+ 3,945	− 213,034	141,198
East North Central				
Ohio	36,103	+ 106,572	− 70,469	735,867
Indiana	285,138	+ 285,138	0	662,822
Illinois	236,972	+ 411,790	− 174,818	1,348,782
Michigan	− 122,352	+ 41,905	− 164,257	470,265
Wisconsin	− 281,392	0	− 281,392	196,996
West North Central				
Minnesota	− 180,281	+ 196,128	− 376,409	711,181
Iowa	− 12,199	+ 200,673	− 212,872	1,530,797
Missouri	155,291	+ 451,176	− 295,885	1,145,854
North Dakota	1,083,790	+1,083,790	0	2,620,181
South Dakota	147,506	+ 257,996	− 110,490	1,860,636
Nebraska	− 537,865	0	− 537,865	1,245,640
Kansas	94,975	+ 315,041	− 220,066	3,989,296
South Atlantic				
Delaware	24,424	+ 24,424	0	37,459
Maryland	44,462	+ 65,731	− 21,269	115,566
Virginia	− 161,148	+ 24,903	− 186,051	122,269
West Virginia	− 142,880	+ 5,471	− 148,351	13,581
North Carolina	− 363,313	+ 13,771	− 377,084	237,355
South Carolina	− 627,808	0	− 627,808	244,930
Georgia	− 1,038,770	0	− 1,038,770	288,393
Florida	217,356	+ 237,057	− 19,701	24,712
East South Central				
Kentucky	− 551,648	0	− 551,648	58,230
Tennessee	− 776,036	0	− 776,036	205,113
Alabama	− 1,010,787	+ 12,419	− 1,023,206	187,140
Mississippi	− 518,943	+ 21,844	− 540,787	710,473
West South Central				
Arkansas	− 377,789	+ 303,780	− 681,569	882,666
Louisiana	− 112,195	+ 96,286	− 208,481	192,343
Oklahoma	− 1,578,263	0	− 1,578,263	1,427,966
Texas	− 3,274,007	+ 323,657	− 3,597,664	3,488,211
Mountain				
Montana	836,677	+ 836,677	0	464,642
Idaho	33,316	+ 86,126	− 52,810	292,027
Wyoming	− 360,308	0	− 360,308	39,705
Colorado	− 1,660,740	0	− 1,660,740	60,505
New Mexico	− 787,730	0	− 787,730	73,033
Arizona	187,680	+ 211,266	− 23,586	68,260
Utah	− 76,446	0	− 76,446	62,716
Nevada	− 44,037	0	− 44,037	858

[a] Source: Same as Table 1. Calculations described in the text.

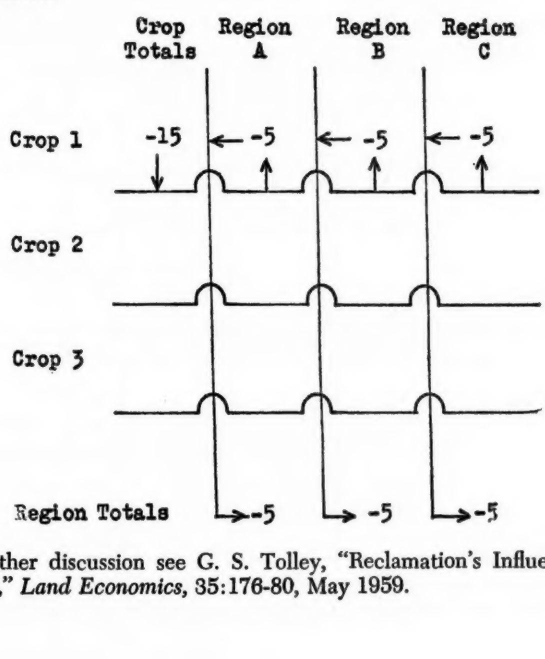
TABLE 2 (*Continued*)

State	Net Change in Harvested Acreage	Analysis of Change for State Economic Areas		
		Sum of Area Expansions	Sum of Area Contractions	Indications of Substitution Within Areas
Pacific				
Washington	124,991	+ 188,011	− 63,020	547,563
Oregon	87,863	+ 137,320	− 49,457	213,690
California	399,918	+ 544,043	− 144,125	343,204
Totals	−11,364,457	+6,511,454	−17,875,911	27,251,314

significant substitutions. It is not at such a clear disadvantage as New England, and changes may be more dependent on happenings in the whole of agriculture. The role of the Mountain states, along with some in the Western Great Plains, may be similar to the South. While Pacific states present a mixed picture, a conjecture is that they are less marginal. The expansions reflect in part reclamation and other land development activities that tend not to be reversed once the development has taken place.[2]

Equilibration Between Areas: An Approach and Some Findings

Consider a 3-crop 3-region agriculture where, due to final demand considerations, the first crop must be reduced 15 million acres. Suppose the three regions are identical. Then we can construct an *acreage-change matrix* as follows:



[2] For a further discussion see G. S. Tolley, "Reclamation's Influence on the Rest of Agriculture," *Land Economics,* 35:176-80, May 1959.

The arrows represent direction of causality. The arrow coming out of the -15 cell indicates it is the beginning of a chain of reactions. This cell is the source of the shock being imposed on the system. The arrow going into the cell for the first crop in each region shows how the shock is transmitted to each of the regions. The arrows coming out of these cells show that there are further effects in each region. There is only one further effect in this example, namely a contraction of harvested acreage in each region. This is the end of the chain, as indicated by the arrow coming into each region total cell where the contraction is registered.

An illustrative set of supply relations for each region consistent with the above matrix is

$$\begin{aligned} a_1 &= 20p_1 - 5p_2 - p_3 \\ a_2 &= -5p_1 + 10p_2 - 8p_3 \\ a_3 &= -p_1 + 8p_2 + 15p_3 \end{aligned}$$

The a's are regional acreage change for each crop, and the p's are price changes.[3] By solving these relations using the postulated final demand conditions ($3a_1 = -15$, $a_2 = 0$ and $a_3 = 0$), the price changes that go along with the results of the above matrix are found to be $-625/1255$, $-1540/1255$ and $-250/1255$ respectively.

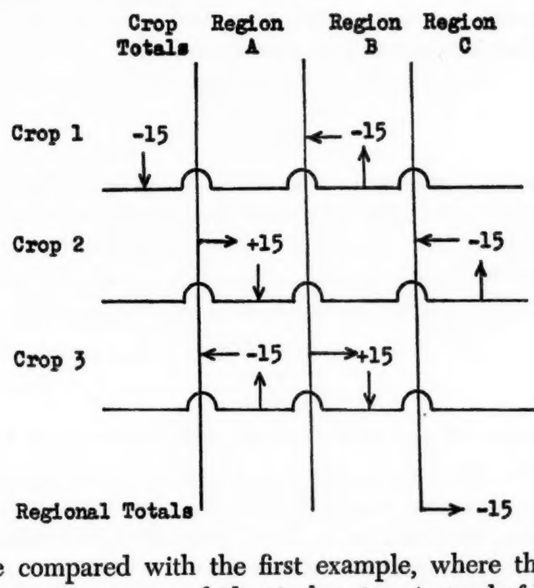
We can drop the assumption of fixed amounts for final demand and visualize demand functions where price influences consumption. The shock leading to the 15 million acre decline for the first crop is now a shift in the demand function for that crop. With the price declines induced by the shift, the markets for the second and third crops expand. The acreage change matrix might then be

	Crop Totals	Region A	Region B	Region C
Crop 1	-15	-5	-5	-5
Crop 2	+1.5	+.5	+.5	+.5
Crop 3	+3	+1	+1	+1
Region Totals		-3.5	-3.5	-3.5

[3] These relations are obtained by taking differentials of demand functions for land.

Let us contrast the preceding two examples, where all regions were assumed identical, with an example where regions are extremely different. Region *A* is not marginal agriculturally, i.e. it has a given amount of acreage that will be in production regardless of the range of prices encountered. Region *A* produces only the second and third crops. Region *B* is likewise not marginal, and it produces the first and third crops. Finally, the agriculture of Region *C* *is* marginal, and it produces only the second crop. Because Region *C*'s agriculture is marginal, its harvested acreage expands or contracts according to demand conditions.

Suppose aggregate production of the first crop is to be reduced 15 million acres, with the other two crops unchanged. The only possibility is for Region *B* to reduce production of the first crop. Hence Region *B* goes into more production of the third crop, forcing a reduction on Region *A*. Region *A* turns to the second crop. The contraction is transmitted to Region *C*, which reduces its total harvested acreage. Here is the acreage-change matrix showing this chain:



This may be compared with the first example, where the same shock was imposed on an economy of identical regions instead of heterogeneous ones.

In the present example, instead of identical regional supply relations, we might have the following. For Region *A*:

$$a_{2A} = 20p_2 - 20p_3$$
$$a_{3A} = -20p_2 + 20p_3$$

For Region *B*:

$$a_{1B} = 25p_1 - 25p_3$$
$$a_{3B} = -25p_1 + 25p_3$$

And for Region C:

$$a_{2C} = \quad 10p_2$$

By combining these with the final demand conditions,[4] it is found that $p_1 = -14{,}250/5000$, $p_2 = -7500/5000$ and $p_3 = -11{,}250/5000$.

This sketch of an approach to studying inter-areal supply relations may be completed by asking: How is the direction of the arrows determined? To answer this, consider the arrows for one of the cells of the last example —Crop 3 in Region A.

The arrow to or from the *horizontal* bar indicates whether changes connected with Crop 3 from outside the agriculture of Region A are forcing adjustments to be made in this cell or, conversely, whether this cell is forcing Crop-3 changes to be made outside the agriculture of this region. The signal for adjustments that are imposed from outside the region is received via the price for Crop 3, i.e. shifts in acreage of this crop in other regions or in total demand for the crop will induce changes in the cell via price of the crop. From the regional supply relationship for a_{3A} the change associated with the third price is $20p_3$ or, in view of the price solutions of the preceding paragraph,

$$\frac{-(20)\ (11{,}250)}{(5000)}$$

This measures the tendency for the arrow to come in from the horizontal bar. On the other hand, the tendency for the arrow to point in the opposite direction (i.e. for this cell to impose adjustments on other regions) is measured by all the influences on a_{3A} excepting the third price. The regional supply relation indicates the tendency is $-20p_2$ or

$$\frac{(20)\ (7500)}{(5000)}$$

If the third price did not influence the cell, there would have to be adjustments of the third crop in other regions just compensating for the $-20p_2$.[5] In the present example the second price is the only influence on the cell excepting the third price. More generally, the tendency to impose adjustments on other regions is measured by:

$$\begin{array}{rcl} \text{influence of all crop prices} & & \text{shock associated} \\ \text{excepting price of the} & + & \text{with the cell} \\ \text{crop grown in that cell} & & \end{array}$$

[4] The demand conditions are: $-15 = A_1 = a_{1B}$, $0 = A_2 = a_{2A} + a_{2C}$ and $0 = A_3 = a_{3A} + a_{3B}$.

[5] If the row total were not fixed by demand considerations, part of the adjustment might take the form of change in total acreage.

An illustration of shock associated with the cell is technological change affecting the regional supply relation. To return to the present example, the absolute value of tendency to force adjustments on the cell from outside the agriculture of the region has been found greater than for the cell to force adjustments on the outside. Therefore the arrow connected with the horizontal bar is drawn coming in.

The arrow to or from the *vertical* bar has to do with the cell's relations with the rest of Region A. The cells of the region communicate with each other via price signals. The regional supply relation for a_{3A} indicates that the tendency of other crops to impose adjustments on the cell in question is $-20p_2$ or

$$\frac{(20)\ (7500)}{(5000)}$$

This calculation appeared in the preceding paragraph since it is part of the adjustment that may be transmitted on to other regions as part of a chain of reactions. A general expression for the tendency of the rest of the region to impose adjustments on the cell is:

influence of all crop prices
excepting price of the crop
grown in that cell

The opposite tendency, i.e. for this cell to impose adjustments on the rest of the region, appeared in the preceding paragraph as influence coming in from other regions. Here the same influence appears as a tendency to be transmitted on. Any shock associated with the cell would appear as additional influence of the cell on the rest of the region. Since there is no cell shock in this example, we have only $20p_3$ or

$$-\frac{(20)\ (11{,}250)}{(5000)}$$

Since this is greater than the tendency for the rest of the region to impose adjustments on the cell, the arrow attached to the vertical bar is drawn going out.

If a cell has one or more arrows going out but none coming in, it is an initiator of a chain of reactions. If a cell has an arrow coming in and also one going out, it is in the middle of a chain. And if it has one or more arrows coming in but none going out, it is at the end of a chain.

American agriculture is at neither of the poles represented by these examples containing either identical regions or extremely different regions. Real chains can be more complex, and interpretation of adjustments is made difficult because the effects of several shocks are usually being

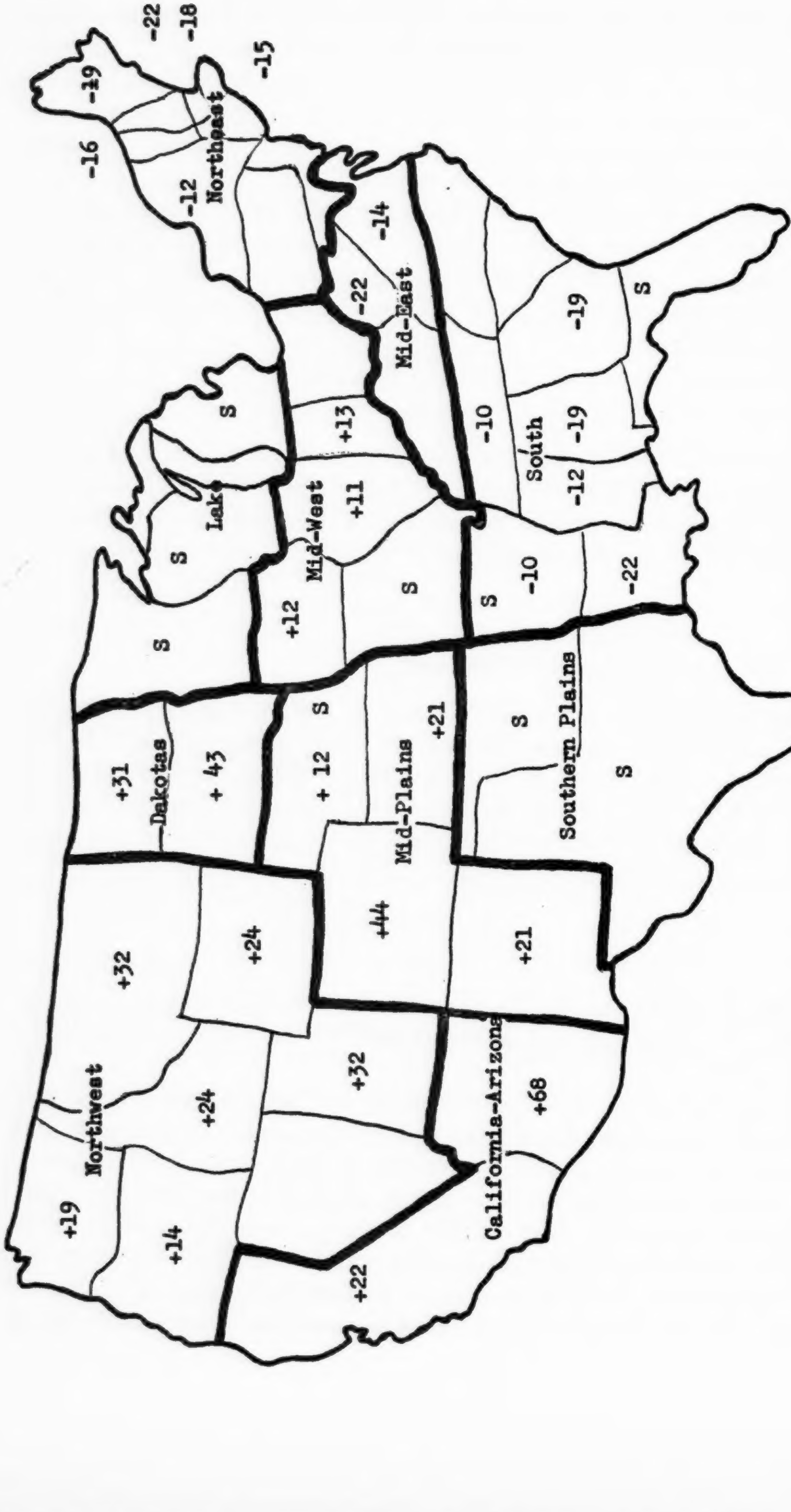


FIGURE 1. PERCENTAGE CHANGES IN HARVESTED ACREAGE AND INDICATIONS OF SUBSTITUTION WHEN 10 PER CENT OR GREATER, BY STATES (1939-1949).

felt at once.[6] Figure 1 shows changes in harvested acreage and indications of substitutions for 1939-1949.[7] The regional breakdown on this map has been used in constructing an acreage-change matrix which embodies hypotheses about major chains during this period.[8] According to Figure 2, three initiators of chains were the row totals for wheat, cotton and "other." These are interpreted as the major shocks, reflecting increases in demand associated with war. There are less important initiators of chains along the bottom of the matrix, namely the declines in total acreage for the Northeast, Mid-East and South. The Northeast reflects the long term trend associated to some extent with urban encroachment. The other initiating regions were especially severely out of equilibrium in 1939, due to dammed-up population pressure that was relieved by urban job opportunities at the end of the depression. In other words these region totals may reflect chiefly population exodus. The effect of both the row and column chain initiators tended to be expansionary for the rest of agriculture. The chains worked themselves out to a slight decrease in hay and to increases in harvested acreage for many regions—most importantly the Dakotas and Mid-Plains.

The Dakotas and Mid-Plains are revealed to have been marginal areas. The effect of wheat on them gives a simple chain much like the first hypothetical example. However, the matrix brings out some indirect effects on these areas. The arrows suggest how (a) the aggregate increase in cotton, (b) the declines in total acreage in the Northeast and South and (c) displacements within the Midwest may have all contributed, via corn and hay, to the total acreage expansions in the Dakotas and Mid-Plains.

Figures 3 and 4 present results for 1949-54. The row initiators of chains reflect contraction in demand from the high wartime levels. There are no important chain initiators along the column totals, as the South and Southern Plains have now become chief ends of chains. For this period they are interpreted as being marginal areas, and it is assumed their total acreage might not have declined were it not for the decline in demand. There appears to be an important indirect working out of a chain affecting the South. Wheat was the chief chain initiator, and the South was a chief marginal area even though it had only a relatively minor wheat adjustment. A hypothesis is that the declines in wheat in the center of the country led to greater feed and livestock production there and displaced production that would otherwise have taken place in the South.

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[6] The fact that yields change is not a serious limitation if they change by the same amount in all regions. Yield effects could be allowed for in a more extended analysis.

[7] The measure of substitution is explained on p. 457.

[8] Thanks are due to persons from the 48 Experiment Stations who responded to a survey of opinions on reasons for acreage change. The acreage-change matrixes for the United States have been constructed partly on the basis of these answers. However, those who answered should not be held responsible for the interpretations here.

FIGURE 2. ACREAGE CHANGE MATRIX: 1939-49[1] (MILLIONS OF ACRES)

	Net Change	N'East	Mid-East	South	Mid-West	Lake	Dakotas	Mid-Plains	S.Plains	Cal-Ariz	N'West
Wheat	20.6	2/	-.2	-.2	.4	.3	5.1	6.6	5.0	2/	3.6
Corn	-3.6	-.2	-.9	-6.7	3.7	1.8	1.4	.5	-3.1	2/	-.2
Hay	-.3	-1.0	.2	-2.1	-1.3	-1.3	2.5	2.4	.2	.1	2/
Cotton	3.8			.6	.2			.2	2.0	.7	
Other	2.7	-.8	-.1	1.6	3.3	.3	1.0	-1.5	-2.9	.9	.9
Total	23.2	-1.9	-1.1	-6.7	6.2	1.1	10.0	8.2	1.2	1.8	4.3

Sources: U. S. Dept. of Commerce, *United States Census of Agriculture: 1954, General Report,* Vol. II (Washington, D.C.: Govt. Print. Off., 1956), pp. 34, 606-811; *United States Census of Agriculture: 1950, General Report,* Vol. II (Washington, D.C.: Govt. Print. Off., 1952), pp. 48-57; *United States Census of Agriculture: 1940, General Report,* Vol. III (Washington, D.C.: Govt. Print. Off., 1943), p. 771.

[1] Arrows explained in text. For the original acreage figures "Net Change" is the row sum and "Total" is column sum. These sums do not hold exactly in the matrix as shown, due to rounding.

[2] Magnitude of change less than .05.

[1] Arrows explained in text. For the original acreage figures "Net Change" is the row sum and "Total" is column sum. These sums do not hold exactly in the matrix as shown, due to rounding.
[2] Magnitude of change less than .05.

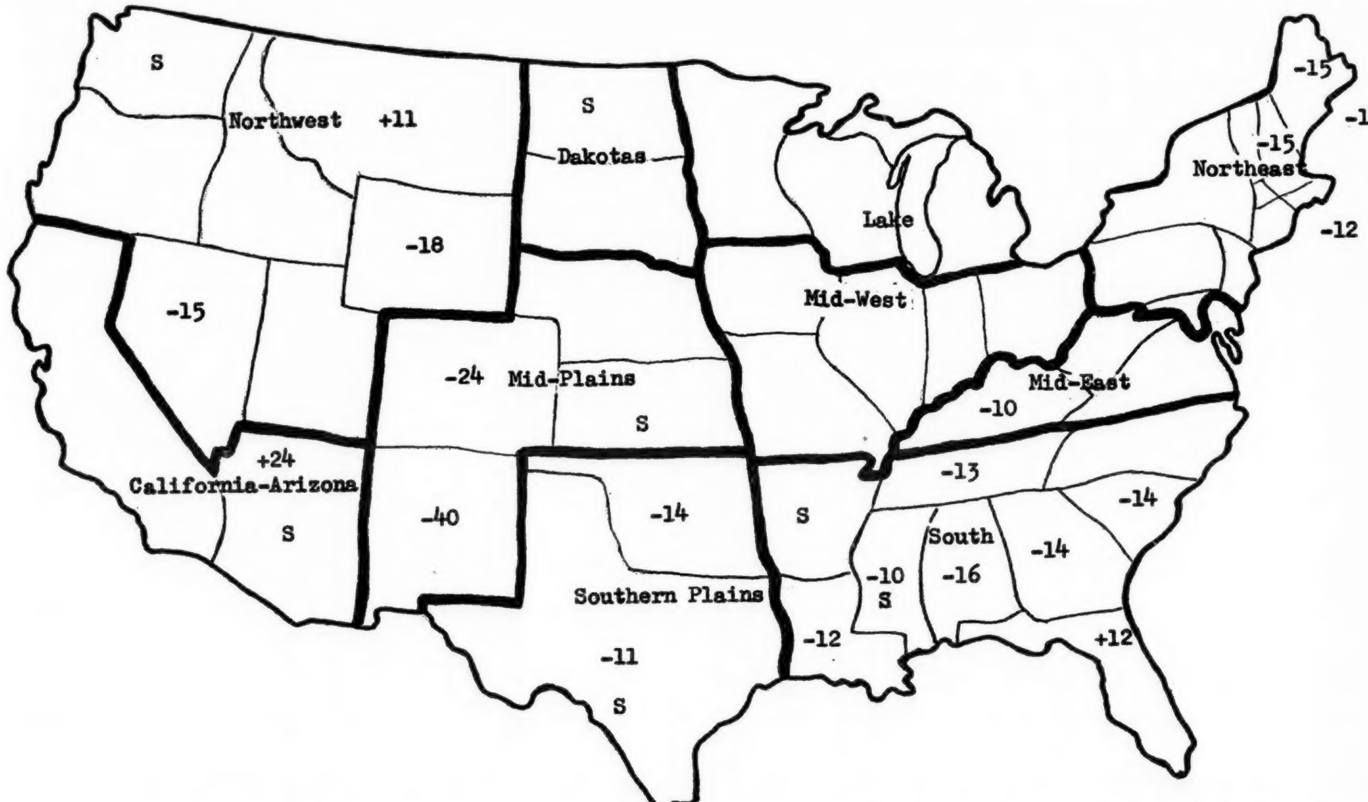
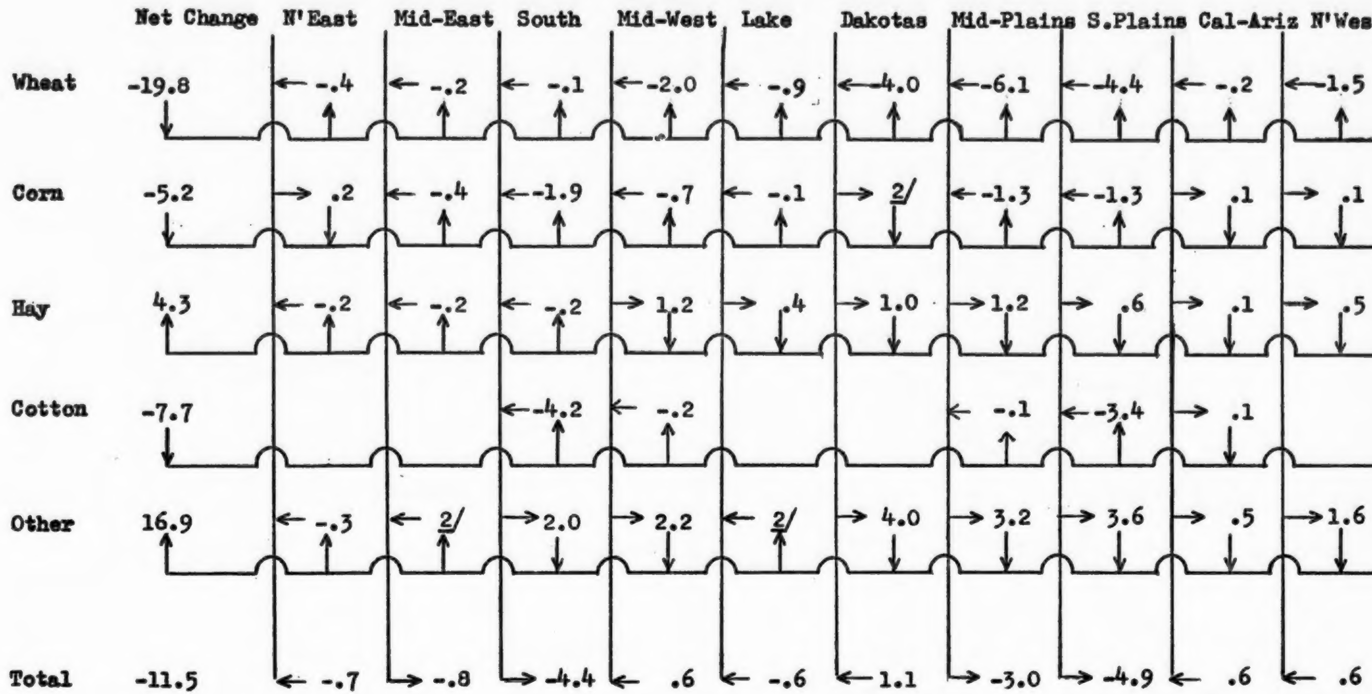


FIGURE 3. PERCENTAGE CHANGES IN HARVESTED ACREAGE AND INDICATIONS OF SUBSTITUTION WHEN 10 PER CENT OR GREATER, BY STATES (1949-1954).

FIGURE 4. ACREAGE CHANGE MATRIX: 1949-1954[1] (MILLIONS OF ACRES)



Source: U. S. Dept. of Commerce, *United States Census of Agriculture: 1954 General Report,* Vol. II (Washington, D.C.: Govt. Print. Off., 1956), pp. 34, 606-811.

[1] Arrows explained in text. For the original acreage figures "Net Change" is the row sum and "Total" is column sum. These sums do not hold exactly in the matrix as shown, due to rounding.

[2] Magnitude of change less than .05.

So the 4.4 million acre decline in total acreage for the South is after all a chief end of the chain that begins with the 19.8-million-acre row-total decline for wheat.

Why did the Dakotas and Mid-Plains expand in 1939-49 and then fail to decline very much in 1949-54? This may be due in part to advantages associated with mechanization. However, it may also be associated with the effect of federal acreage controls. In contrast to wartime expansions, postwar contraction in wheat was administered by acreage cuts. Some acreages have been cut relatively less than they would have been by price signals, so the method of control has made other areas—perhaps the South and Southern Plains—share more fully in agricultural contractions.

These applications suggest that acreage-change matrixes can be useful. Even when there is a high degree of aggregation, the matrixes have value in forcing a consistent interpretation of adjustments taking account of ideas about totals.

To summarize, a conception of regional dependency in agriculture was presented. Measures of expansion and substitution adjustments were developed. These revealed a great deal of both types of adjustment consistent with the conception of regional dependency. Hypothetical chains of reaction were devised, and these were found to have real counterparts in U.S. agriculture. The chains showed how expansions and contractions in the demand for agricultural products as a whole may end up chiefly affecting marginal areas. There were indications that federal acreage controls have had pronounced effects on the location of production.

Appendix

The differential of the acreage demand function for the ith crop in the jth region is

$$a_{ij} = {}_S s_{ij} S + {}_r s_{ij} r_j + \sum^{k} {}_k s_{ij} p_k \tag{1}$$

where S is a row vector of changes in variables other than prices that influence acreage demand, ${}_S s_{ij}$ is the column vector of partials of the acreage demand function with respect to these variables, r_j is change in the opportunity return to land in the jth region, ${}_r s_{ij}$ is the partial with respect to this opportunity return, p_k is change in the price of the kth crop and ${}_k s_{ij}$ is the partial with respect to this price. The a_{ij}'s are entries in the acreage-change matrix.

The row total for the ith crop in the matrix is:

$$A_i = \sum^{j} a_{ij} \tag{2}$$

For each row total there is a final demand relation:

$$A_i = {}_D d_i D + \sum^{k} {}_k d_i p_k \tag{3}$$

These demand relations are obtained by first dividing aggregate demand function for the ith commodity by national average yield, so that the aggregate demand is expressed as a function of total acreage of the crop. The demand relations (3) are the differentials of these functions, where ${}_kd_i$ is the partial of the function for the ith crop with respect to the kth price, D is a row vector of changes in variables other than prices that influence demand and ${}_Dd_i$ is the column vector of partials with respect to these latter variables.

When yield differences between regions are important, (2) and (3) may be replaced with

$$Q_i = \sum^{j} {}_{ij}y \, a_i \tag{2'}$$

$$Q_i = {}_Dd_i' \, D + \sum {}_kd_i' \, p_k \tag{3'}$$

where ${}_{ij}y$ is yield and Q_i is change in production of the ith crop. It has been assumed that differences in price changes between regions and effects of regional adjustments on yields are of an order of smalls that can be neglected. If these assumptions are not wanted, further modifications of (3) can be made.

The column total for the jth region is:

$$B_j = \sum^{i} a_{ij} \tag{4}$$

There is a land supply relation pertaining to each of these region totals:

$$B_j = {}_Tt_jT + t_jr_j \tag{5}$$

where T is the row vector of changes in variables other than opportunity return affecting land supply, ${}_Tt_j$ is the column vector of partials with respect to these variables and t_j is the partial of land supply with respect to opportunity return. Opportunity return, whose change is measured by r_j, may be thought of as the general level of rental return to land in the region. For regions with fixed land supply, t_j is zero. For regions with completely elastic supply of land, t_j is infinite so the opportunity return for such a region is constant (governed perhaps by a cost of bringing land into production). It might sometimes be a useful approximation to classify regions into these two categories of completely non-marginal or completely marginal. Then all the opportunity returns would be either irrelevant to land supply or constant, and the r_j's could be eliminated. The main hypothetical example of the text was of this type.

If there are m crops and n regions, the sets of equations (1) through (5) give a system involving $mn + 2m + 2n$ endogenous variables. Appearing in the acreage-change matrix are $mn + m + n$ of these (the a_{ij}'s plus the m row totals and the n column totals). The other endogenous variables are the m changes in crop prices and the n changes in regional opportunity returns to land.

FIGURE 5. ILLUSTRATION OF SOLUTION FOR CELL CHANGES

FIGURE 5. ILLUSTRATION OF SOLUTION FOR CELL CHANGES

$$
\frac{r^{s}_{uv}\left|\;\left|\begin{matrix} k^{\sigma}_{i} \\ k^{\sigma}_{j} \end{matrix}\right|^{x\cdot}\;\left|\begin{matrix} r^{s}_{ij} \\ r^{\sigma}_{j} \end{matrix}\right|^{xv}_{\cdot v}\;\right| + \sum^{k} k^{s}_{uv}\left|\;\left|\begin{matrix} k^{\sigma}_{i} \\ k^{\sigma}_{j} \end{matrix}\right|^{xk}_{\cdot k}\;\left|\begin{matrix} r^{s}_{ij} \\ r^{\sigma}_{j} \end{matrix}\right|^{x\cdot}\;\right|}{\left|\;\left|\begin{matrix} k^{\sigma}_{i} \\ k^{\sigma}_{j} \end{matrix}\right|\;\left|\begin{matrix} r^{s}_{ij} \\ r^{\sigma}_{j} \end{matrix}\right|\;\right|}
$$

The shocks are imparted by S, D and T. Each cell in the acreage-change matrix has a unique shock associated with it. This is the term involving S, D or T in the equations that have been given for cells of the matrix. Suppose we want to know the effect of the shock associated with the xth crop in the yth region on the uth crop in the vth region. This is found by first solving for changes in prices and opportunity returns to land and then inserting these values in the expression for a_{uv} as indicated by (1). The resulting value for a_{uv} is the amount shown in Figure 5 times the shock ${}_{S}s_{xy}S$. The notation used in Figure 5 is as follows:

$$ {}_{k}\sigma_{i} = -\,{}_{k}d_{i} + \sum^{j} {}_{k}s_{ij} $$

$$ {}_{k}\sigma_{j} = \sum^{i} {}_{k}s_{ij} $$

$$ {}_{r}\sigma_{j} = -\,t_{j} + \sum^{i} {}_{r}s_{ij} $$

Vertical bars on either side of an expression denote a matrix composed of the elements of the expression. Subscripts to a matrix indicate deletions from it. The first subscript indicates a row deleted, and the second subscript indicates a column deleted. Since y does not appear in the solution, Figure 5 shows that the effect of a shock associated with a particular crop is the same regardless of what region it occurs in. The effect of the shocks associated with each cell is additive, so the change in the uth crop in the vth region is the sum of the effects on this cell of all the shocks that occur in the system.

The generalizations of rules for drawing arrows in the acreage-change matrix are as follows. Direction of arrow depends on relative magnitude of *in* and *out* influence. For the row total A_i, influence coming *in* is the effect of own price on ith demand, ${}_{i}d_{i}\,p_{i}$. Influence going *out* is demand shift

$$ {}_{D}d_{i}\,D + \sum_{i \neq k}^{k} {}_{k}d_{i}\,p_{k} $$

For the column total B_j, influence coming *in* is the response $t_j\,r_j$ of land supply to opportunity return, and influence going *out* is land supply shift ${}_{T}t_{j}T$.

This pertains to the a_{ij} elements:

Direction of Arrow	*Column*	*Row*
OUT	${}_{S}s_{ij}\,S + {}_{i}s_{ij}\,p_{i}$	${}_{S}s_{ij}\,S + {}_{r}s_{ij}\,r_{j} + \sum_{k \neq i}^{k} {}_{k}s_{ij}p_{k}$
IN	${}_{r}s_{ij}\,r_{j} + \sum_{k \neq i}^{k} {}_{k}s_{ij}\,p_{k}$	${}_{i}s_{ij}\,p_{i}$

Consider three components of a_{ij}. The first component ${}_{S}s_{ij}S$ is exogenous, imposing compensations (arrow *out*) for the row and the column via identities (2) and (4). The second component is ${}_{i}s_{ij}\, p_i$ induced by happenings elsewhere along the row, which are connected via identity (2). This comes *in* from the row and imposes adjustment (arrow *out*) for the column. The third component is

$$ {}_{r}s_{ij}\, r_j + \sum_{k \neq i}^{k} {}_{k}s_{ij}\, p_k $$

region influence coming *in* via the column identity and transmitted via row identity *out* to rest of country.

A check on the arrow scheme is that the sum of the *in* and *out* influences is always the total change for the cell. The scheme has done nothing more than trace where the cell influences are emanating from.

The acreage-change matrix may provide a way for bringing together coefficients from other supply analyses deriving from the farm firm, from time series data and from regional optimizing studies concerning particular crops.[9] This appendix has discussed the acreage-change matrix for an economy where demand and supply is equilibrated solely by prices. Where control programs or other influences change the nature of equilibration, endogenous variables may need to be added and in some cases prices deleted.

AGRICULTURAL SUPPLY ANALYSIS: DISCUSSION

GLEN T. BARTON
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Dr. Johnson takes a broad view of agricultural supply analysis in his paper on "The State of Agricultural Supply Analysis," despite his emphasis on the theory of asset fixity. This broad view is good because it stresses the many complex forces that must be considered in explaining production response in agriculture. The emphasis on complexity also helps to explain why we have been relatively unsuccessful in providing a more adequate analytical basis for policies and programs intended to bring about needed adjustments in farm production and resource use.

My brief review of this paper is divided into two parts. First, I shall

[9] Examples of the three kinds of analyses just mentioned are, respectively, J. D. Black and Ronald L. Mighell, *Interregional Competition in Agriculture* (Cambridge: Harvard Univ. Press, 1951), Marc Nerlove, "Estimates of the Elasticities of Supply of Selected Agricultural Commodities," *J. Farm. Econ.*, 38:496, May 1956; Earl O. Heady and Alvin C. Egbert, "Programming Regional Adjustments in Grain Production to Eliminate Surpluses," *J. Farm Econ.*, 41:718, Nov. 1959.

single out Dr. Johnson's conclusions regarding the present state of supply analysis which I feel deserve special emphasis. Second, I shall enumerate the questions that occurred to me regarding Dr. Johnson's new contributions to the theory of fixity of assets and the potential usefulness of this tool in analyses of production response.

Without denying the importance of further efforts on studies of commodity supply response, I strongly endorse Dr. Johnson's emphasis on the need for more adequate studies of response for the entire agricultural industry. I share his view that the best aggregative studies probably must await improved commodity analyses. However, this does not preclude giving added emphasis to research on aggregative studies in the meantime.

Dr. Johnson's stress on the importance of asset fixities in supply response is well taken, especially in view of the importance of asset fixities in explaining the nonreversibility of the response curve.

The need for developing a better understanding of the managerial process in studying supply responses is another of Dr. Johnson's conclusions that deserves emphasis. A broad research attack in this area may be an important means of bridging the gap between "normative" and "predictive" models of production response.

Dr. Johnson provides us with a new theory of fixed inputs which promises to be a useful tool in studies of supply response. However, I am certain that he would be the first to agree that his new contribution goes only part of the way toward providing us with a complete theory of production response.

His theory of asset fixities rests on the proposition that "in agriculture, off-farm acquisition costs for factors of production typically exceed off-farm salvage values." In an earlier paper, Dr. Johnson summarized his theory as follows: ". . . an asset will be defined, very simply and crudely, as fixed 'if it ain't worth varying.' More elegantly stated, an asset will be defined as fixed so long as its marginal value productivity in its present use neither justifies acquisition of more of it or its disposition. If the acquisition cost and salvage value of an asset are substantially different, the asset can remain fixed while the price of the product it produces varies both absolutely and relatively over wide ranges. If, on the other hand, as is commonly assumed in using the marginal apparatus, the acquisition cost of an asset is equal to its salvage value, any variation in product price relative to the price of the asset will cause either acquisition or disposal of the asset."[1]

Later in the same article, he classified agricultural inputs into nine rea-

[1] Glenn L. Johnson, "Supply Function—Some Facts and Notions," *Agricultural Adjustment Problems in a Growing Economy*, Ed. by E. O. Heady, H. G. Diesslin, H. R. Jensen, and G. L. Johnson, Iowa State College Press, Ames, Iowa, 1956, pp. 78-79.

sonably homogeneous categories with respect to behavior of acquisition costs, salvage values, and marginal value productivity. Hypotheses were developed about employment of each input category during phases of the business cycle. Data on aggregate use of the various input groups in United States agriculture as a whole from 1910 to 1954 were then examined to test the hypotheses. Conclusions about the nature of the aggregate supply curve for farm products were developed from hypothesized relationships among acquisition costs, salvage values, and marginal value productivities with doubled "normal" prices of farm products and with normal prices halved.

A few random thoughts occurred to me in trying to appraise the potential usefulness of Dr. Johnson's addition to the kit of tools for supply analysis.

1. His theory, as developed thus far, relates to the individual firm. Moreover, it seems chiefly a "normative" approach. Can it be further modified, perhaps by incorporating results from studies of the managerial process, to become more nearly a predictive device?

2. Dr. Johnson has as one of his suggestions for future work the development of theories for aggregation of marginal cost structures for firms into commodity and sector supply response concepts. How can the rapid trend to fewer and larger commercial farms be handled in developing the theory of aggregation?

3. A closely related question concerns the difficulty of aggregating when one considers the range in age of farm durables at any point in time and the shifts that occur in age composition of durables over time.

4. How will the growing importance of custom operations in agriculture affect the responsiveness of input use and of output through eliminating or narrowing the gap between acquisition costs and salvage values? This question applies both to Dr. Johnson's firm theory and to the yet-to-be-developed aggregate theory.

5. How does one measure the acquisition cost and salvage value of family and operator labor? I can visualize some basis of measurement in the case of part-time employment of operator and family labor at nonfarm jobs. This increasingly important means of transfer of labor resources from agriculture to the nonfarm economy deserves more attention in our research efforts and should be incorporated into models of production response.

6. Dr. Johnson's theory on asset fixity applies essentially to responses in the short run. Can the theory be modified to make it adaptable to intermediate and longer term analyses? This seems desirable if we are to provide a more adequate basis for policy decisions and program development in agriculture.

7. As I studied the paper, I was impressed with the magnitude and complexity of the problem of assembling the kinds of data needed to put the new ideas to an empirical test. I hope Dr. Johnson can develop some specific suggestions along this line.

8. Finally, if I interpret it correctly, I like very much Dr. Johnson's simple statement of the major objective of supply analysis—"What we seem to need is estimates of changes in quantities with respect to price under changing conditions." A broad interpretation of "changing conditions" would include technological advance, changes in factor markets, variations in the net worth position of producers, improvements in the human agent and in managerial ability, as well as other important factors affecting production response.

Dr. Johnson obviously includes under changing conditions the difference in rates of response of production to price under expansion and contraction of production. Because of the importance of recognizing the general nonreversibility of the supply curve, I share Dr. Johnson's view that the absence of specific measures of price elasticity of supply is not a major calamity.

I was unable to prepare an adequate review of Dr. Tolley's paper owing to late arrival of his paper. Some observations are possible, however, based on an abstract of his paper and on an earlier article in which he outlines the general principles of his acreage-change matrix.

Dr. Tolley suggests a way of organizing data on changes in acreages of crops by regions which can be useful in developing hypotheses about inter-areal relations in supply changes. The acreage-change matrix should be useful in ferreting out regions and crops that merit further study regarding major factors in production response.

His reliance solely on changes in acreage bothers me. Although we have had important changes in crop acreage in the United States, the dominant factor in supply changes during the last two decades has been the large increase in yields of crops. Some recognition of the yield factor is needed in organizing data to throw light on inter-areal relations in supply changes.

Additional light might be thrown on inter-areal relations in supply changes if data on livestock numbers and production and on quantities of major inputs used were organized in a matrix similar to that developed for crop acreages.

AGRICULTURAL SUPPLY ANALYSIS: DISCUSSION

HAROLD W. WATTS
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I would like to compliment Mr. Johnson and Mr. Tolley on their very interesting papers, and I must also thank the Chairman for inviting me to comment on them.

I should explain at the outset that I am here as an econometrician, not as an agricultural economist. Some of you may wonder in the next few minutes whether or not I really am an econometrician. I assure you that I have assumed the title only to excuse my ignorance of the substance of agricultural economics. The following remarks will be primarily concerned with the theoretical and methodological aspects of the papers. Should these comments contain foolish statements concerning substantive matters, I beg your indulgence as an econometrician among agricultural economists.

I will first comment upon Mr. Tolley's paper. Every beginning student in economics is taught that the ultimate impact of a tax may be quite remote from the nominal object of taxation. Except for this, and an occasional invocation sometimes accompanied by hand waving, the notion of general equilibrium tends to be overshadowed by the tidyness of the tools of partial analysis. There is a need perhaps for more tools which take explicit account of the interrelations among economic processes. Such devices must be more comprehensible than a set of two-N or so equations and must provide a frame for organizing and interpreting presently available data. This is, of course, a tall order but it has been filled by the input-output analysis, to mention an outstanding example. It has also been filled by the acreage-change matrix presented by Mr. Tolley.

It must be granted, and kept clearly in mind, that such devices are special purpose tools. Simplicity demands that many features of the structure be ruthlessly abstracted from and aggregated over. This specialization can be a positive advantage as long as the analysis is carefully used, but care must be taken to avoid overuse. The acreage-change matrix shows the changes in acreage for each of several crops disaggregated by geographical area. It provides an overall view of adjustments and shifts that have taken place over a period of time. Its chief value is in providing a unified picture which forces attention toward the complexity of the adjustment process. An observer who is more familiar than I am with the main exogenous forces which have caused agricultural adjustments can perhaps follow the chains of adjustments, and benefit from the discipline of consistency imposed by the matrix. It is important to note that the chains do not appear automatically and without a great deal of information from outside the table.

A word of caution may be in order regarding the kind of aggregation employed in this and any other inter-regional analysis. All sorts of farms and all sorts of farmers are lumped together and it is therefore hazardous to proceed from generalizations about the South or Mid-West, as areas, to statements about the typical Southern or Mid-Western farmer. The adjustments which are of interest from an economic point of view must be taking place among types of farms and may be largely obscured by geographical aggregation.

Moving on to Mr. Johnson's paper, I would like to pass over the first part, which reviews past work, with the remark that I found it very informative and well organized. I speak here only as a consumer, since I cannot qualify as a critic.

I will concentrate my remarks on the modification of the theory of the firm which Mr. Johnson proposes. As an addition to the theoretical tools of the statical analysis his suggestions are interesting, ingenious and helpful. I do not think, however, that they do the job they were intended to do. The analysis proposed, as I understand it, assumes that there are two prices for a factor at a point in time, a buying price and a selling price. The bases for such price differentials would seem to lie in transportation costs, selling costs, or risk concerning the quality of the factor (as contrasted with risks concerning the course of future prices). Price differentials based on these costs are not inconsequential but are probably minor when compared with the price changes that may take place over time.

If price changes which take place over time are to be considered, and it is clear from Mr. Johnson's examples that they are, then we must admit to attempting dynamic analysis with static tools. We must also allow the possibility of selling prices which are higher than acquisition prices. This last consideration would greatly complicate the analysis proposed by Mr. Johnson. This criticism does not imply that asset fixity deserves little or no consideration in supply analysis. Neither does it disparage the main conclusion reached by Mr. Johnson, namely that the elasticity of supply response may be different for expansion and contraction. It does suggest that the conclusion should be based on a resolutely dynamical analysis which allows for capital gains as well as capital losses.

With regard to the use of these notions in empirical research, some sort of distributed lag technique, perhaps of the Koyck type suggested by Nerlove, may be appropriate to account for delayed adjustments caused by asset fixities. A modification of Nerlove's procedures may be needed to allow for different adjustment rates under expansion and contraction. I have not tried to formulate an estimating procedure for such a model but I see no great obstacles which would prevent it.

ANNUAL DINNER MEETING, AMERICAN FARM ECONOMIC ASSOCIATION

CHAIRMAN: BUSHROD W. ALLIN, AGRICULTURAL MARKETING SERVICE, USDA

ORGANIZATION AND STRATEGY FOR AGRICULTURAL ECONOMICS WORK

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The Words and Their Meaning

THERE are two major issues here: (1) The relationship of "organization" and "strategy" to "agricultural economics work" and (2) optimum organization and strategy for given objectives and constraints.[2]

Agricultural Economics Work. Most work in agricultural economics involves some combination of research, service and teaching. *Research* here means the processes of asking and answering answerable questions. *Service* means pragmatically oriented operations. *Teaching* means the processes of developing capacity to comprehend or to use analytical or operating techniques in research or service.

Organization. Organization is a command structure specifying allocation of decisions and jobs, authority within and between units, a penalty or reward system, and mechanisms for reporting, accounting, and appraisal. Vertical organization defines almost absolute authority and program duties with parallel penalty, inducement, accounting and appraisal systems.[3] There should be substantially greater interdependence of functions within than between units on any command level. Superior units supervise and adjudicate functions and decisions of subordinate units only if sensibly interrelated, governing others by removal of personnel. Span of control is determined by degree of interdependence. There neither is nor could be a fully vertical system except as a logical construct.

The flat system specifies operating responsibility of a nominal administrative head but diffuses authority equally among all members of the unit and usually has no accounting, reporting, or appraisal components. Fiscal and perhaps personnel administration of the flat organization must always

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[1] Giannini Foundation Paper No. 187.

[2] These issues encompass the perennial battles of line and staff, of workers and supervisor, and agency objectives and structure as specified by budget sources.

[3] The work of a military unit must be done fast. Therefore, there must be both command and drill in those agencies.

have some vertical attributes in the long run. Thus the purely horizontal unit is also no more than a limiting construct.

There are many intermediates within these two extremes.

Strategy is defined here in its military sense as "the use of engagements to attain the objects of the war."[4] There is usually implicit assumption of overriding objectives, alternative patterns of achieving objectives, and interdependence of organization, strategy, and function. Thus for given objectives and constraints the issue here is the consistency of certain command structures and strategic procedures. Tactics, the process of selecting among alternatives within each of the major elements constituting strategy, is also assumed to be interrelated.

The Questions

To relate organization and strategy to agricultural economics work means to develop and as best possible to test hypotheses identifying the variables, their net relationships, and the system of covariation as the means whereby manipulation of organization and strategy might determine the nature and scope of the work.

Research. These questions involve the relationship of organization and strategy to the:

(1) Kinds of questions asked where such questions may range from "*basic*" analyses of covariation generated out of pure curiosity with no pragmatic or normative content to simple prescriptive or descriptive statements;

(2) Kinds and scope of hypotheses, their sources and the methods for formulating them;

(3) Data specification and collection, testing procedures and measures of confidence or reliability;

(4) Use of research findings to satisfy curiosity, to contribute to theory, or other sources of hypotheses, measurement, testing procedures, formulation and choice of norms, and perhaps advocacy of alternative administrative mechanisms.

Service here means policy and includes: business practices; facilitating services; regulatory or police activities prescribing and enforcing constraints; interventionist operations limiting individual decision making; and any other activities oriented directly to targets. Three major service questions involve the relationship of organization and strategy to:

(5) Formulation of program goals, specification of constraints, and selection of targets among such constrained goals;

(6) Methods of analyzing the determinants of targets;

[4] Clausewitz, Karl von, *On War*, transl. from the German by O. J. Matthijs Jolles (New York: Random House, Inc., The Modern Library, 1943), p. 62.

(7) Development of administrative mechanisms to secure the targets.

Teaching. Here there are also three major questions relating organization and strategy to the:

(8) Teaching of analytical methods;

(9) Teaching of art, skills, or vocational activities;

(10) Definition, selection, and advocacy of norms.

The Hypotheses

Within the profession there seem to be several broad hypotheses, quite inconsistent mutually, generally untested, perhaps not susceptible of test but vehemently advocated.

Inimical, impossible, irrelevant, inevitable, indispensable?

Extreme advocates of the "flat" or "first among equals" command structure at least nominally prevailing among some private agencies often hold that creativity and technical competence do not depend upon any known attributes of organization, strategy, or anything else and cannot be programmed or appraised but do require absolute individual independence. This position implies that research, service or teaching personnel cannot work effectively in any organization or with any strategy. Standard administrative procedures are held to be grossly inapplicable as well as inimical to all types of work.

Other hold that intrusive organization may constrain work but does not affect its quality or scope significantly.[5] This position implies that good work can be done with bad organization; poor work in good organization; with consistent strategy and the "right attitude," good work is possible in almost any organization; and that research, service and teaching of all sorts can be administered simultaneously and perhaps better so if they are sufficiently interdependent in production and demand.

There are theses that organization and strategy almost fully determine the types of questions engaged.[6] Opposite hypotheses posit that virtually

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[5] Thus, O. V. Wells has stated ". . . organization has some importance, but I have seen my friends in the Bureau of Agricultural Economics organized on very logical lines for planning purposes at a time when they were almost ineffective, and I have also seen them organized without regard to any planning or advisory functions at times when they were, if not effective, at least constantly being called upon."

[6] One official of the U. S. Department of Agriculture indicates that in his judgment endowed agencies may ask questions free of the biases always afflicting governmental units; that different organizations induce and require workers to ask different questions, use different methods, and make different use of the findings; and that agricultural experiment station workers almost invariably ask pragmatically-oriented questions. Also see "Report on the State Agricultural Experiment Stations, 1958," Agr. Research Serv., U. S. Dept. Agr., ARS-23-9, May 1959, which sets out its purpose and therefore defines its questions as those the answers to which are likely to ". . . strengthen agriculture through technological progress and improve it in agricultural

any type of research, service, or teaching can be engaged effectively within any organization, given the proper strategy and combining if necessary the facilities of government and the land-grant, private or quasi-private universities.[7] Thus, no organizational structure taken alone is considered to affect agricultural economics work. The interrelations of research, service, and teaching are held to dictate a partially vertical organization, but more important, a continuing and flexible strategy. Many business and government, and some land-grant personnel operate within a vertical system. The commanding officer is nearly always both the technical and the administrative authority—assigning duties, requiring regular reports, nominally accounting for input costs, appraising output value, and distributing penalties and awards.

Opponents hold that an effective research administrator must bridge many objectives and methodologies. Above all, he should foster a working environment consistent with the development of intellectual curiosity and technical competence—and, literally, do nothing more.[8] In short, real administrative organization is held to be unnecessary, impossible and negatively related to the motivations, creativity and competence of workers. This group seems to doubt that a commanding officer can in fact plan,

marketing." See, also, Myers, W. I., "The Agricultural Experiment Station in the Service of the State and the Nation," Rutgers Univ., New Brunswick, N.J., June 12, 1951, 13 p., wherein it is stated that the objective of "agriculture has always been the production of food and fiber for the nation." Another official indicates that the real "reason for being" of agricultural economists is the "welfare" of farm producers. Still another officer has written, "I have also had occasion to observe some of my colleagues who I think have been quite successful research leaders as well as advisers in the field of policy who have followed what appeared to me to be a rather well thought out and more or less deliberately executed strategy—that is, they found themselves in places in rather solid institutions which were well protected by regulation and tradition relating to tenure and academic freedom. From time to time, they sallied forth as advisers or research leaders into other fields but always carefully protected their line of retreat to the institution in question, with the result that they always had the choice of serving as critics, advisers, researchers, or teachers as the case might demand."

[7] "Again, many of the people who talk about organization are the same kind of people who sometimes raise with me the question as to whether we in the Department of Agriculture are free to research on anything that engages our fancy and publish the results forthwith without consultation or censorship of any kind. My answer to this kind of question has always been one of strategy rather than organization. What I have said is that I thought there was a way to get needed research on any problem done and published if one took into account the resources of the Department, the land grant colleges, and the private universities actively working in the field. I am never sure whether any one of these institutions is in a position to immediately do wholly objective work on any subject that one might mention. You are also aware that a bad organization with enough financing to hire good people does a better job than a good organization which finds that its financial resources have evaporated." O. V. Wells, letter to author, June 26, 1959 (quoted with his permission).

[8] See Heiskell, Andrew, "The Role of Marketing Research in Today's Business Management," MTA Paper No. 1, Bur. of Bus. and Econ. Res., Mich. State Univ., 1958, 21 p.

coordinate, schedule, appraise, or otherwise administer the actual functions involved. It is implied that administrators always push applied work. They assert that neither costs nor values can be measured and that penalties and rewards bear little relevance to actual motivations of workers. In short, it is alleged that real rather than nominal application of administrative techniques would mean sure ruin for the organization.[9]

Another group, apparently of men who have done both research and administration, seems to hold that strategy and organization taken alone are meaningless; that objectives, functions, and organization of agencies are closely interrelated; and that, in consequence, different organizations and strategies are required for different functions. Given appropriate strategy, a single administrative organization may effectively include many different functions, related both in production and demand, and resulting therefore in a variety of administrative structures within a single agency.[10] These men concede that the more "basic" the work, the less stringent is the optimum administrative structure. They also concede that goals and functions may be systematically associated with the amount and sources of budgetary support.

The active issue here is whether present research, service, and teaching organizations—given the strategies, if any, of their administrators—provide effective environments for work except for those few people who can be creative in any environment. There is real and respectable controversy involving desirability or even possibility of mixing facilitating, regulatory, and interventionist programs together with research, teaching, and other types of professional activity, and equally warm disagreement with respect to the need or even the usefulness of any command structure.

The hypotheses or preconceptions here

Agencies without clearly defined and consistent goals seem to produce little work despite massive organization and often bloodthirsty strategy. Multiple goals are desirable if they and their determinants are interrelated

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[9] There are counter views. Thus, W. I. Myers holds that investment in agricultural research and education is an investment in public welfare rather than an expense to government. He also holds, "There is ample evidence to prove that, in the aggregate, public funds devoted to agricultural research make a higher return on the investment." Myers, *op. cit.*, p. 1.

[10] Wells has stated, "I would define 'strategy' as covering not only organization per se, but also the question as to how to make organization work, or the steps necessary to successfully bring agricultural economic skills to bear on problems which need to be examined. That is, I suspect that quite a few of our friends who talk a great deal about organization are in fact concerned with the problem as to how to get the kind of research done which they feel should be done, and I for one would suggest that this is far more a problem of strategy than it is of organization by itself."

in production or demand or both. Different organizations and strategies are necessary to optimize the use of personnel and support to achieve different targets—be they ideas, status or groups. It is possible, efficient and sometimes necessary simultaneously to encompass different types of research, service, and teaching agencies within a single administrative organization. Outturn of a mixed product of different kinds of research, service, and teaching may in fact contribute most effectively to developing the environment needed for each one. Further, there may and apparently often are demonstrable economies of jointness in production, attainable without violence to creativity or technical competence. Basic research seems best to flourish within the flat administrative structure.[11] The closer the objectives approximate technical service or direct policy operation, the greater are the necessity and usefulness of vertical organization. Beyond doubt, given reasonably effective strategy, it is and long has been possible to operate multiple-purpose agricultural economics agencies with effectively different organizational structures for different functions and to do so consistently with all of the objectives involved, even where one individual may perform several functions and therefore be subject to a variety of command systems. Organization, strategy, and tactics should be designed to obtain and keep the people and facilities necessary to the agency objectives. Objectives may encompass a wide variety simultaneously and may involve ideas, individuals, or the status and development of the group. A very few research and teaching agencies may appear to be, or may appear to think that they are, free of all service or vocational elements. Yet, research and teaching functions appear nearly always to be related to service activities within the agency itself or with respect to some closely related unit. "Pure" teaching or research—if such there really be—may be impossible of attainment except in combination with other functions.

There is as much and as "pure" research—and perhaps teaching—in the Department of Agriculture and similar agencies as in any university or other unit. There seems to be a strategic necessity over the long run for work of other types in all agencies. Again, it is surely possible and perhaps desirable to combine research, service, and teaching objectives in a multiple-purpose agency with what amounts in fact to different organizations for the personnel involved in each of the different purposes and with

[11] This is the fundamental administrative organization of the University of California. Its teaching programs are unequivocally the province of the faculty at large. Its research programs are technically subject to approval by a series of first among equals but entire power for generation of personnel actions and fundamental academic programs lies in the group of academic people alone. At the same time, substantial service programs operate within a vertical system. Generally, the actual operation of the system cannot be understood in terms of the apparently-governing instruments.

strategy and immediate tactics designed simultaneously to achieve the multiple goals. While straight service operations may require vertical command structures, some organizations, in fact, also provide ample latitude for inclusion of units of the flat type. Total strategy must encompass related agencies and different purposes if only to assure long-run budgetary support, and aside from this to assure most effective performance of all functions. Basic strategy, therefore, appears in fact to be much more important than formal administrative structure, given the multiplicity and interrelatedness of targets.

Several hypotheses emerge. Agencies should have and know goals. Many objectives can be encompassed within one agency. Different organizations and strategies are optimal for different targets and constraints. Different individuals may effectively assume different functions within different administrative structures to achieve a specific conglomerate of interrelated objectives. Such interrelations seem nearly always to dictate some combination of research, service, and teaching functions. A real administration is probably not possible for basic work. It seems necessary and desirable for related types of work which contribute directly, if sometimes only in the long run, to achievement of objectives.

No one seems really to know the origin of ideas or of analytical, teaching, or even administrative skills.[12] Outstanding research people seem to have a largely unexplained capacity to develop questions and hypotheses and—from an apparent native talent enhanced by drill and drudgery—a capacity to use analytical devices. Some workers can simultaneously perform many different functions, or develop analytical work on many questions, or avail themselves efficiently of large-scale staff assistance. Others cannot.

Organization and strategy taken separately are meaningless. The three broad functions or objectives in terms of which they are meaningful encompass many different combinations that are nearly always interdependent. The three functions usually must be performed in order than any one of them may be supported effectively. An agency must know its purposes and fit its administrative structure thereto, but there appear to be no really stringent difficulties in a multiplicity of objectives, functions, and organizations—combining various versions of the vertical and flat systems as necessary within a single unit. There appear to be no logical or empirical bases to conclude that single-purpose agencies are necessarily the most efficient vehicles even for the attainment of a single purpose.

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[12] A study is underway to identify the determinants of creativity, to measure their interrelationships and to determine the variables which may be manipulated to enhance creativity. The original project statement included another question. Why are women not creative? This almost totally defeated the attainment of support. Retreat was both tactical and strategic in nature.

Organization, Strategy, and Work

The formal separation of agricultural economics work into research, service, and teaching can be paralleled by equally formal classification of agricultural economics agencies into business and industrial units; governmental agencies; land-grant institutions; and others. Their functions may serve as measures of their purpose; it may then be possible to determine how they are reported to be organized; perhaps in a few cases to identify apparent strategies; and then to appraise the interrelations, if any, among the purposes, structures, and strategies. For most agencies, organization and strategy are complex and unstable. These are going institutions governed by custom, precedent, and personalities. Operating personnel often pay little heed to organization or high strategy. There appears generally to be more liberty to do more things in different ways than most operating personnel are disposed to accept. Sometimes the governing instruments do not reflect actual function or structure.[13] Appraisal of the purposes, organization, strategy, and the interrelations thereof of business, government, and academic agencies may serve as a rough—but probably the only possible—test of these hypotheses.

Business Economics. Many companies now have economic research departments, but only a minute part of expenditure in these, or any other types, supports basic research.[14] Their work is tailored to the necessity of executives to make forecasts affecting the future income position of the company. There are many other specific functions.[15] There is no standard organizational pattern.[16] Members usually become consultants to high-

[13] Dr. M. L. Upchurch wrote: "In thinking about research and the organization for research, I can't escape the idea that, after all, research is done by people. Almost any organization will work, if the people in it want it to work. Personally, I am much less concerned about organization for research than I am about getting and keeping properly qualified people who are motivated to do research."

[14] See Horne, William M., Jr., "Research and Development Expenditures," *Tax Revision Compendium* (U. S. Cong., House of Repr., Comm. on Ways and Means, Washington, D.C.: Nov. 1959), pp. 1115-23; Cairns, Robert W., "Income Tax Provisions Regarding Research and Development Expenditures," *ibid.*, pp. 1105-09; Orem, Charles R. Jr., "Research and Development Costs," *ibid.*, pp. 1111-13; Nat. Science Found., Proc. of a Conf. on Research and Development and its Impact on the Economy, NSF-58-36; Nat. Science Found., Reviews of data on research and development, No. 14, NSF-59-46, Aug. 1959.

[15] Teitsworth, Clark S., "Growing Role of the Company Economist," *Harvard Bus. Rev.*, Jan.-Feb. 1959. This includes such diverse activities as public relations statements; inventory policy; internal decision making; potential measurements; personnel training; plant location; labor relations; new product and package developments; assistance in court cases and speech writing; handling of pension funds; production scheduling; equipment replacement; plant-capacity projections; product development; diversification proposals; and a variety of others.

[16] Arthur, Henry B., "Research and the Executive," Address at the Univ. of Georgia, Athens, April 18, 1952, p. 10; "The Company Economist—A Commentary," 8 p.; and "How Should the Industrial Economist Operate for the Best Long-Time Results," *J. Farm Econ.*, 36:916-20, Dec. 1954.

level officers. The departments nearly always report directly to the president. Strategy seems to involve continuous exposure of the economists to the decision-making processes of the executives. The business economist must work and communicate within a going business context. He engages a relatively narrow range of questions. Precision and methodology are determined by need and cost. Yet, in many organizations there is more elegant and basic work than in many academic institutions. The economist is a staff adjunct to a profit and loss enterprise, in a simple command structure. Alternative organizations could not have much effect upon the scope, the nature, and the methods through which this service function is performed.

Governmental Work. The agricultural economics work of the U. S. Department of Agriculture includes teaching, service, and research. It is closely coordinated with work in land grant colleges and state universities. There are four broad administrative units, each headed by an Assistant Secretary—Federal-State Relations; Marketing and Foreign Agriculture; Agricultural Stabilization; and Agricultural Credit Services.[17] Committees and other administrative devices tie together the related work of the several agencies.[18] Farm economics research centers in the Agricultural Research Service, the Administrator of which is also responsible for coordination of all departmental research. Some research and technical service functions are performed by the Farmer Cooperative Service, the Foreign Agricultural Service, the Farm Credit Administration, and the Forest Service.[19] The Agricultural Marketing Service—like ARS—has a much broader responsibility.

Agricultural Research. Like AMS, ARS has two major functions: research, including since 1954 the work of the Farm Economics Research Division and some peripheral work in other divisions; and a wide variety of regulatory programs. A few less important other functions are assigned to this agency also.[20] The Farm Economics Research Division "carries on a national program of economic and statistical research on farm problems involving the economic use of labor, land, buildings, and equipment in

[17] See U. S. Dept. Agr., *Agricultural Research Service, Organization, Coordination, Nature, Location,* Misc. Pub. No. 779 (Washington: Govt. Print. Off., Nov. 1958), 94 p. See charts on pages 5 and 6.

[18] See, for example, "Advisory Committees Established Under the Research and Marketing Act of 1946," USDA Departmental Memo., Dec. 13, 1957, 2 p.

[19] See, for example, U. S. Dept. Agr., *Extension Activities and Accomplishments, 1958,* Ext. Serv. Circ. No. 522 (Washington: Govt. Print. Off., June, 1959), 34 p. Also, Summary No. FCS 1, "Current Research and U. S. Department of Agriculture Projects of the Farmer Cooperative Service," *Research and Technical Assistance for Farmer Cooperatives,* April 1959, 14 p.

[20] U. S. Dept. Agr., Agr. Research Serv., *Questions and Answers on Agricultural Research* (Washington: Govt. Print. Off., 1957), 44 p. See pp. 18-20 for functions of ARS; pp. 26-27 for functions of the Farm Economics Research Division; and pp. 28-29 for description of the regulatory and control activities of the Service.

farm production, and adjustments in farming to technological developments and changing market outlets."[21] The Division reports to a Deputy Administrator responsible for research divisions in agricultural engineering, animal disease and parasites, animal husbandry, crops, entomology, and soil and water conservation. The work of FERD may in fact be more closely related to other research divisions or perhaps even to other program divisions. There are straightforward authority and responsibility lines.[22]

The Agricultural Marketing Service. This service operates a complex set of programs facilitating and regulatory; some, but not much, of federal support and control; teaching; and research, ranging over many commodities, functions and methods.[23] AMS reports through an Assistant Secretary responsible for Marketing and Foreign Agriculture, to whom the heads of the Foreign Agricultural Service and the Commodity Exchange Authority also report. There is an obvious duality of function in AMS, well represented by its organization.[24] Seven commodity divisions and two functional divisions constitute the marketing services component. Except for the partial removal of stabilization activities, these agencies are quite similar to what they were under PMA.[25] There are now two research units: Marketing Research and Economics and Statistics, with four divisions in each. Division functions cover a broad spectrum from basic to vocational and policy issues. As in ARS, organization reflects function.

One issue is whether such multiple functions and consequent multiple organizations are mutually consistent; and consistent with objectives and functions in other agencies. Another is whether the research work of AMS and other units might be improved if they were consolidated.[26]

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[21] U. S. Dept. Agr., Agr. Research Serv., *Farm Economics Publications Currently Available,* Washington, D.C., July 1958, ARS-43-78, p. 1.

[22] See, for example, Admin. Memo. 102.7, Agr. Research Serv., May 14, 1958, in which basic organization is charted. Admin. Memo. 102.1, Feb. 26, 1959, lays out the organization charts for economics research. Organizational materials may also be obtained in "Organization and Activities of the Agricultural Adjustment Research Branch," "Functions and Activities of the Land and Water Research Branch," "Organization and Activities of the Cost, Income and Efficiency Research Branch," FERD, ARS, Aug. 1958. An excellent summary of work done by FERD may be obtained in "Accumulated Collected List of Approved and Discontinued FERD Line Projects," FE Div. Not. No. 53-11, Washington, D.C., July 25, 1958.

[23] For example, see U. S. Dept. Commerce, *Activities and Services of the Federal Government in Distribution Research—A Summary Report* (Washington: Govt. Print. Off., Sept. 1957), pp. 29-30. See Summary No. MR-1, Projects of the Marketing Research Division, Agr. Marketing Serv., April 1959: Field and miscellaneous crops; fruits and vegetables; livestock, meats, and wool; dairy products; poultry products; cross-commodity and functional studies.

[24] See Agr. Marketing Serv., U. S. Dept. Agr., Oct. 9, 1959, Table of Organization.

[25] It has been alleged that the shift from commodity to functional organization in the Department had, among other things, as one objective the dilution of political power alleged to have developed within the PMA divisions.

[26] See Pelz, Donald T., *What Motivates Research Workers,* Proc., Amer. Assoc. of

The Experiment Stations and the Land Grant Institutions. Most of these agencies undertake all types of work except government service programs. Experiment Stations formally report and account to ARS. The nature, scope and interrelations of teaching, service, and research seem to differ sharply among different experiment stations and their associated colleges or universities.[27] On the average—and with wide variation—about one fourth of state experiment station costs are financed from federal funds. These are "distinctly state institutions" with no nominal control by the federal Department of Agriculture. There are regional and national co-ordinating agencies. Generally, there is a simple line-organization of vertical command down to the departmental level. The vehicle of research administration is the "individual narrow line segments of research known as projects."[28]

There is an immense difference among these colleges and universities in work and strategy. In some, experiment station personnel have no part in academic or personnel matters. In others, Experiment Station Directors and Deans appear to have and to exercise direct and virtually military authority. Thus, there is no standard pattern relating apparently similar organization to scope, nature, and quality of work.

The strategy

There are no formal statements of strategy. Some approximation may be adduced from apparently stable procedures. Both ARS and AMS appear to avail of all government, state, land grant, or other units doing agricultural economics work. The strategy, if such it be, also seems designed to avail of interdependent functions within and among the units in order to widen the scope of work and perhaps to lift its quality in some collaborating units. Both have concentrated on regional and national problems as much as possible toward the "basic" work.[29] Both agencies appear to adjust quickly to changing problems, interests and methodologies without constraint from organization.

Land Grant Colleges and State Universities, 71st Ann. Convention, pp. 176-177. Pelz indicates that ". . . periodic regrouping of personnel is one way to provide fresh ideas."

[27] Purposes, and generally speaking, the functions of experiment stations, land grant colleges, and state universities are outlined in, *Questions and Answers on Agricultural Research, op. cit.*, p. 4; "Agricultural experiment station, P. Meyer, Experiment Station Administrator, Office of the Experiment Station, pp. 249-250B, May, 1957"; "Cooperation in the Administration of the Federal Grant Funds for Agricultural Research," H. C. Knoblauch, Director, State Expt. Sta. Div., ARS, U. S. Dept. Agr., Jan. 23, 1957, 17 p., typed; "Report on the State Agricultural Experiment Stations, 1958," *op. cit.*

[28] Meyers, *Encylopedia Americana.*

[29] See Shaw, B. T., *Proceedings of American Association of Land-Grant Colleges and State Universities,* 72nd Ann. Convention, Washington, D.C., November 10-13, 1958, p. 166. Strategy seems also to imply that support for "basic" ideas is related to scope, quality, timeliness, and relevance of work which from the view of budget sources would be classed as service.

It is possible but not demonstrable that these two major agencies would prefer to have no formal service and no teaching programs within their agencies, and to confine themselves respectively to closely related physical and economic research—with all service functions elsewhere—in neatly tailored administrative organizations. Over the past five years, strategy has been such that organization seems not to have been fatal or even seriously hurtful to any assigned goal. On the contrary, both within and between these agencies and with others, systematic effort has been made to complement production processes to develop products interrelated in demand. These agencies at least appear to consider that within reasonable limits multiple objectives, functions, and administrative structures within a single agency—given the appropriate strategy—are mutually consistent and perhaps desirable.

Other agencies[30]

A few private universities do agricultural economics work. Research and teaching appear to be closely integrated and fairly basic. Industrial and foundation grants are sought as one source of support. There is little agricultural economics work and standard pattern among foreign universities or other agencies.[31] Most foundations have either wholesale budgets, conduct service programs, or in a few cases undertake basic work.

In short, agricultural economics work appears to be done in the main by a combination of the U. S. Department of Agriculture, state college or university agencies, and other public or quasi-public units.

Summary Statement

The issues here are the relations of teaching, service and research to organization and strategy, and the means whereby this work can be affected through changes in organization or strategy. Organization ranges within the conceptual limits of the flat to the vertical command systems, although neither limit could be realized in practice. Strategy means the

[30] Descriptions of some Rockefeller Foundation programs may be found in: "The Agricultural Program of the Rockefeller Foundation," J. G. Harrar, New York, 1956. Directors' Annual Reports for Agricultural Programs in various countries are also available. Similar reports outline the work of the Council on Economic and Cultural Affairs, which is almost entirely devoted to agricultural economics work. Descriptions of the functions and organization of the Agricultural Research Institute of the National Academy of Sciences, National Research Council, are available in their proceedings numbers. National Science Foundation work and organization are described in their annual reports. Similar statements describe the activities of the National Bureau of Economic Research, other private or quasi-public agencies and a variety of research units supported by commercial enterprise.

[31] See, United Nations, Food and Agriculture Organization, "Index of Agricultural Research Institutions in Europe," Rome, June 1957, 201 p., and, for example, Abbott, John C., "Information on Marketing Publications in Other Countries," FAO, Rome, 1958.

combination of major operational decisions designed to achieve overriding objectives of research, service, and teaching. The specific questions involve the relation of organization and strategy to types of research questions, hypotheses, methodology and use; the formulation, selection, analyses and advocacy of program targets and operating mechanisms to secure them; and to methods of analytical, vocational, and normative teaching. Most explicit or implicit hypotheses are inconsistent; largely untested and perhaps not formally testable; and imply that organization may be inimical, impossible, irrelevant, inevitable or indispensable as a determinant of work. Views seem to be warmly held and stated.

Organization and strategy are meaningful only in terms of objectives and constraints. First, therefore, agencies should know their goals. Generally, such objectives are multiple and are related both in demand and in production. Perhaps this is inevitable and, with proper strategy, desirable. The mixing of facilitating, regulatory and interventionist programs with research, service, teaching, or other types of professional activity creates real and respectable controversy. The seating of closely related research functions in separate administrations also provokes disagreement.

The objectives of any working agency must be internally consistent. Different types of administrative structure and strategy appear to be most effective for different functions. Yet, given the political, statutory or other constraints under which most agencies must operate, if only to obtain budget, it appears possible and often desirable to combine functions and administrative mechanisms within a single agency. There are serious difficulties of the "no administration" hypothesis even in agencies the work of which approximates a single and a "pure" function. Similarly, outright vertical organization, particularly if associated with a really military strategy, would almost surely cripple creativity in any agency.

Agricultural economics work can be done effectively with many organizations, provided that strategy is consistent with goals and structures. Formal descriptions of administrative structure do not represent objectives or constraints or the combination of structure and strategy that seem in fact to determine quality and nature of work.[32]

In business units, work is intended primarily to facilitate management decisions. Organization is almost always a simple consultative relationship. Strategy seems mainly to involve continuous exposure of the consultant to the business environment of the executives. Work is service oriented but much of it is more basic than in most public universities.

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[32] See Kiehl, Elmer R., "Integration of the Sciences for Effective Research," *J. Farm Econ.*, 39:1230-41, Dec. 1957. See, also, Brinegar, George K., Kenneth L. Bachman, and Herman M. Southworth, "Reorientations in Research in Agricultural Economics," Social Science Research Council, *Items*, vol. 13, no. 1, pp. 1-4, March, 1959.

The major governmental agencies for agricultural economics work are parts of a total administrative machine operating in a political context, supported by public funds and encompassing a variety of objectives other than agricultural economics work. Organizational structures existing prior to 1954 might be more effective means of securing the present objectives of agricultural economics work. Yet, there appears to be no evidence that the mixing of objectives—including research, service, and teaching—with other goals has created an administrative mechanism measurably inimical to any part of the work. Operating strategy seems to have overcome the apparent organizational weakness of locating closely related research units in different structures of command. Whatever evidence is available indicates that effective strategies have been developed to counter any seriously adverse effect of administrative structure.

Organization of ARS and AMS reflects the duality of objectives—service and research—in each. FERD *is* more closely related in terms of productive-inputs and product-demand to parts of AMS than to other parts of ARS. Yet, actions of administrators, the only indices of strategy publicly available, seem to have rendered the multiplicity and heterogeneity of objectives within each agency compatible with goals. And the separation of FERD may be undesirable but it does not appear to have had adverse effect, in general, on any part of its work or on the work of related units in AMS and elsewhere.

The organization of Experiment Stations is in general quite similar among states. But constraining effect of tradition in academic components and strategy of all administrative officers does not show in formal descriptions of organization. Structure *plus* strategy range from almost flat to almost vertical command, and therefore to a range of work almost purely service in nature at one extreme to basic at the other.

Available evidence indicates that for most agencies a variety of objectives and functions may be necessary and even desirable to the achievement of any one of them; that a wide range of alternative administrative structures may be developed; and that if associated with appropriate strategy, work may be effectively carried on under many of the alternatives. In many cases, agricultural economics work is undertaken in an administrative context not susceptible of short-run change by administrators. Rules may be set by other agencies and for other purposes. Nonetheless, effective strategy seems to have compensated for administrative deficiency wherever personnel are competent and motivated to work. There seem to be no really stringent limitations upon the research, service and teaching functions uniquely or even primarily attributable to organization alone. Perhaps administrative strategy explains deficiencies in work. There may be other reasons.

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REVIEWS

Problems and Policies of American Agriculture, Earl O. Heady, Ed. Ames: Iowa State University Press, 1959. Pp. viii, 460. $3.95.

This is a symposium volume consisting of papers presented at a conference sponsored by the Center for Agricultural Adjustment, Division of Agriculture, Iowa State College, in October, 1958. The purpose of the conference was to bring together a selected group of agricultural economists to discuss the nature, causes, and possible solutions for the major problems of commercial agriculture. It was designed in such a way as to provide useful factual summaries, interpretations of these facts and a considerable variety of ideas as to kinds of research needed in the field of agricultural policy. Hopefully, it would "provide . . . a systematic assembling of ideas which educational, research, and administrative personnel might find of use in programs of their own institutions and states" (Preface, page v). The conference was made possible by a grant from the W. K. Kellogg Foundation.

As in all such undertakings, the papers vary considerably in quality and usefulness. In part, that is due to the fact that some of the topics assigned were more manageable than others. Unfortunately, the number of contributions is so large that they cannot all be discussed effectively or even listed in a review of this kind. For the full list of papers given, the reader should look to the book itself.

The first major paper, "Recent Changes in Resource Use and in Farm Incomes," by Sherman Johnson and Kenneth Bachman, is a very useful summary of a sizable amount of research that has already been done, mainly in the U. S. Department of Agriculture. The attempt to relate experience to theory (page 14) is somewhat less than satisfying, but it must be recognized that the authors were operating under rigorous space limitations. The second paper, "Prospects for Agriculture in a Growing Economy," by G. T. Barton and R. F. Daly is likewise a very useful summarization of information that is available from other sources but in much more scattered and uncoordinated form.

The third paper, "Dimensions of the Farm Problem," by D. Gale Johnson, presents a view that has had too little recognition in the scramble to use data based on comparisons with 1951, the peak year of inflation in farm prices. Johnson says (page 49), "The available evidence definitely indicates that farm families have shared fully in the general increases in real incomes that have occurred in the United States during the past century." Undoubtedly, this conclusion will be challenged, but the challengers should equip themselves with equally good or better evidence

than Johnson provides. A somewhat similar tone pervades John D. Black's paper on "Societal Obligations to and of Agriculture." Unfortunately, the full implication of this thoughtful paper cannot be discussed in a brief review of this kind.

While the papers mentioned above make real contributions, both of factual information and thinking, there is room for question about some of the others. For example, "Social, Economic and Political Values of Farm People," by Paul Miller, leaves one with some doubt as to the adequacy of the historical background drawn on. For example, "In the South the more aristocratic peoples identified themselves with cities, and with professions and trade and maritime commerce" (page 82). Did they? Most historians would be skeptical. Furthermore, can we take very seriously sentences like the following (and there are many of them): "The second locus of contemporary rural value orientation is that constellation of attitudes or outlooks about the nonfarm world—not only in reference to entering it, but about the prevalent interdependencies of public affairs and the incongruities of technologic innovations and the aggregate market place"?

The thoughtful paper by Karl Fox, "Economic Instability and Agricultural Adjustment," warrants careful reading and is a useful contribution to an over-all view of the problems considered by the conference. That can hardly be said of the succeeding article on "Economic Adjustment—An Instrument of Political Preservation" by Charles Hardin, though the fault may lie partly in the phrasing of the topic assigned. Granted that the dangers facing us in the world of today are grave ones, it is far from clear that what we do or don't do in agricultural policy or in research about it will determine the outcome. Surely we need to improve the foreign phase of our agricultural program but "drastically [cutting] agricultural as well as other tariffs" is not the answer, desirable as it may be on other grounds. Our tariffs are already lower, on an ad valorem basis, than they have been at any time since 1816. More important, there would be little reason to expect heavy increases in imports of agricultural products if tariffs were removed entirely. That might be a good gesture but why would we be likely to increase materially our imports of wheat, corn, cotton, tobacco, pork, beef or even of wool and sugar?

The partisan excursion into general international policy is neither convincing nor helpful in this setting. Personal opinion is after all personal opinion. It is far too early for any one, even Walter Lippmann, to know whether the so-called Dulles policies were sound or unsound. There is a certain naïveté in such oversimplifications. In modern government, major policies are not the product of any one man's thinking, even a President or Secretary of State. At any rate, are these the kinds of political

problems on which agricultural economists can make their best contributions?

John F. Timmons emphasizes in his paper, "Land Institutions Impeding and Facilitating Agricultural Adjustment," a phase of the problem that is all too frequently overlooked in most of the current discussions of farm policy. It is less than adequately recognized in most of the papers presented at this conference. One wonders at times whether the analysts are actually talking about people in a complex and deeply rooted social structure or are playing some sort of game in which the checkers differ only in color, not in quality, size, interests and aspirations. This writer at least would have been glad to see a further and more comprehensive discussion of these institutional factors than Timmons has provided, rather than the somewhat overformalized schematic presentation on page 172, which reverts in some measure to the timeless type of analysis which he very properly questions in other sections of his paper.

Dr. Schultz's paper on "Omission of Variables, Weak Aggregates, and Fragmentation in Policy and Adjustment Studies" presents a number of interesting ideas, but it does not follow that all of his readers will agree with him. "The remarkable growth in agricultural production is neither classical or neoclassical in nature." True? If so, most of the other papers given should have been omitted. He also would cast aside the historical, institutional and welfare approaches as unsuitable. But does that leave very much in the way of tools to work with? Schultz very properly critizes the omission of changes in wealth and certain other factors. Are these outside the purview of economic analysis or have we merely been somewhat remiss in developing measurements for them?

In the matter of national aggregates, a word of caution is needed. Certainly we must have them and we need to do a better job of defining and measuring them, but also we must recognize that they conceal as well as reveal. For example, how useful is an aggregate figure for wheat when two-thirds of the surplus is of one kind of wheat grown in one area? Though better measurements are needed for the kinds of things Schultz mentions, we can't assume that once such measurements are available the problem will be solved. This is well brought out in a recent statement by Nourse in testimony before the Senate Subcommittee on Antitrust and Monopoly[1] in which he said:

> A free economy is not a precision instrument, with narrow tolerances, and unquestionable external control. It is a loose assemblage of working parts, with wide tolerance of different and even inconsistent ways of functioning and subject to conditioning rather than control from the outside—that is, society—and to

[1] *Hearings on Administered Prices,* Part I, p. 13, July 9, 1957 (and repeated in his paper, "Some Questions Emerging Under the Employment Act," 72d Annual Meeting of the American Economic Association, Washington, December 29, 1959).

power drives, insubordination, and compromise from within. Economics does not furnish us means of physical measurement, mathematical deduction, laboratory experiment, and pilot-plant demonstration comparable to those of science and engineering. We still have to rely to a large extent on pragmatic tests and popular value judgments. We await the revelation of gross defects in practical operation to point the direction of reform and get acceptance of needed change. . . .

Schultz's stress on excessive fragmentation and lack of really scholarly effort in agricultural economic studies is well taken. But most of our agricultural economists nowadays are not being trained as scholars. They are being trained as technicians. As technicians, they are very much better than their predecessors. But how many of them are equipped to pick up, on the broader issues, where Edwin G. Nourse, John D. Black, Henry C. Taylor, Joseph S. Davis and George Warren left off? In policy matters we are far too prone to use the tools of econometrics rather than the more comprehensive kit that includes philosophy, history, political science and economics in a broader context. But these are some of the tools Adam Smith, Ricardo, John Stuart Mill, Henry George and others of the older school were attempting to use, and did use with some success, though without the refinements and comprehensive factual foundations that are now available to us. We can and do question the usefulness of their thinking when it is applied to our present-day world. But they were not talking about twentieth century America. In their time and in the world they were trying to understand, they had a profound influence. Will our successors be able to say as much for the contributions of our age, even though we have many many times as much manpower and vastly more factual information?

But to return to the volume under review, Earl Heady tackles the problem of "Feasible Criteria and Programs." Certainly he has not given us definitive answers on this difficult problem. Nevertheless, he has opened up some lines of thought which warrant further exploration by those engaged in study of these problems. Perhaps he undertook to cover a wider range of topics than can be dealt with in a single paper.

Space is not available even for brief comment on all of the other papers presented. Glenn Johnson and Joel Smith ("Social Costs of Agricultural Adjustment—With Particular Emphasis on Labor Mobility") attempt a rather elaborate type of analysis of mobility adjustments but leave, as this reviewer sees it, some question as to whether classification and measurement techniques haven't been overstressed in comparison with more fundamental considerations. After all, these are people we are talking about, not chickens, pigs, or sheep.

Willard Cochrane, in "Demand Expansion . . . Opportunities and Limitations," presents a well-balanced and realistic discussion except in

Parts III and IV in which he deals with the export side of the problem where he concedes that his discussion is "more tenuous" than in the preceding sections. This reviewer would disagree with a number of his statements and conclusions in these sections, but space is not available for discussion of them.

The remaining papers, though worthy of more extended review than can be given them here, deal for the most part with smaller segments of the problem. Hence no comment is made. This does not mean that they lack significance, though some of them surely are less important than those discussed in the papers mentioned above. To do full justice to the wide range of subject matter dealt with in the volume as a whole would call for separate reviews of many of the more important papers. The aim has been rather to give the reader a general idea of the scope of the volume and to encourage him to read it for himself. He will find in it much that is worthy of his attention but also, almost certainly, will not find himself in agreement with everything that is said.

MURRAY R. BENEDICT

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Econometrics, Stefan Valavanis. New York: McGraw-Hill, 1959. Pp. xvii, 223. $7.00.

During the past few years many objections have been raised against the formidable task of understanding the mathematical and statistical jargon necessary to read textbooks in econometrics. Valavanis in his *Econometrics* text has "reduced to common-sense terms" the mathematical statistics on which the theory rests. In addition it has been accomplished in a manner that can be described as delightful and refreshing. His keen insight and ability to understand the problems of others has resulted in a presentation which gets at the meat of the problem without having to crack a very hard shell.

The organization of the book is excellent and the continuity and coverage leaves little to be desired in an elementary textbook in econometrics. The book deals in succession with problems of specification and estimation, the statistical assumptions necessary for estimation, various techniques of estimation, and suggested tests after completing the analysis. The final chapter deals with a series of problems relating to time series and their analysis.

The procedure in each chapter is commendable. Valavanis, in general, begins with an outline of the chapter and follows the outline diligently, with digressions into more complex and detailed statistical problems which he believes are inadequately treated elsewhere.

The shortcoming of this textbook is to be found in the inadequate treatment given many of the topics. For example, the discussion on multi-

collinearity, a problem that plagues many workers, gets treatment of approximately two pages and leaves one wondering if anything can be said about the problem. The same is true for problems of homoskedasticity, serial correlation, bunch map analysis, and factor analysis. If one has not had previous knowledge in these areas Valavanis' text merely presents the topic without a well rounded discussion.

In some cases he resorts to appendices to deal more completely with specific problems and one is left with the feeling that either this should have been done for more topics or such discussion should have been included as a part of the text.

His "layout of computations" will not appear helpful to many persons. Klein gives equally as good treatment to the subject in his *Econometrics* and probably a better procedure is that suggested by Friedman and Foote in the USDA Agricultural Handbook No. 94.

The textbook appears well suited for a first course in Econometrics for students who have had an elementary training in statistics. It gathers together a variety of estimating techniques with which the econometrician should be familiar. The broad coverage of topics makes it well suited for a text and one can turn to additional references if a more adequate treatment of specific topics is felt desirable. Valavanis suggests such references at the close of each chapter.

One can only feel a sense of loss to know that the author's untimely death prevents further treatment of many of these subjects. The profession lost a truly brilliant person.

W. A. CROMARTY

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Science and Research, Prospects and Implications of Technical Advance, Henry Jarrett, Ed. Baltimore: Johns Hopkins Press, for Resources for the Future, Inc., 1959. Pp. 250. $5.00.

This book is the result of a series of six sets of public lectures given in Washington, D.C., under the auspices of Resources for the Future. Each set consists of three articles. The lead paper in each set is authored by an outstanding scientist.

The first major topic, Genetics, is introduced by Dr. George W. Beadle, Professor of Biology and Chairman of the Division of Biology at the California Institute of Technology. Professor Beadle in a clear and concise manner sets forth the material basis of biological inheritance. He raises the question of what will be the result of our ever increasing population.

Henry A. Wallace follows Professor Beadle's paper with a discussion of Genetic Differentials and Man's Future. Oris V. Wells, an agricultural

economist, writes on Agriculture's New Multipliers. Mr. Wells believes that the United States could provide food for a population of 400 million by the year 2000.

Lecture Set II, on Weather Modification, is introduced by Dr. Horace R. Byers, chairman of the Department of Meteorology of the University of Chicago. He advocates the need for acquiring more fundamental knowledge before undertaking a large program on weather modification. The Honorable Clinton P. Anderson, U.S. Senator from New Mexico, comments on weather control, while Dr. Ackerman of Carnegie Institution discusses weather modification and public policy.

Dr. John A. S. Adams introduces the third series, Exploring for Minerals. He advocates a more complete inventory of our mineral resources and a continued search for better techniques of exploration.

Dr. James Boyd, Vice President in charge of exploration for Kennecott Copper Company, points up the fact that in the main there has not been the stimulus of necessity back of mineral research as there has been in some other areas.

Paul W. McCann, Chief Economist of the U.S. Bureau of Mines, discusses the economics of mineral exploration.

The fourth major subject is Chemical Technology. In a very interesting paper entitled "Past and Future Promise," by Earl P. Stevenson, Chairman of the Board of Arthur D. Little, Inc., much is made of the role of chemistry in providing new and substitute material.

Economist Frederick T. Moore, and chemist Richard L. Meier further develop the theme.

Nuclear Energy, the fifth major field, is introduced by Dr. Willard F. Libby, formerly of the Atomic Energy Commission and now a member of the Chemistry Department at the University of California, Los Angeles. This is a very lucid account of nuclear energy sources and their potential for peaceful uses.

Phillip Mullenbach writes on government pricing and civilian reactor technology, and E. Blyth Stason, Dean of Law, University of Michigan Law School, discusses human resources in an atomic age.

The sixth and last section deals with the topic "New Knowledge from Outer Space." Dr. Lee A. DuBridge, President of California Institute of Technology, deals with the topic "Space Exploration: How and Why?" He holds that space exploration will open up fantastic new fields for research and exploration.

Allan L. Dean writes about our national space program. The last paper is on the international opportunity by Phillip C. Jessup, Professor of International Law at Columbia University.

The developers of the plans for the series of lectures from which this

book emerged recognized that they were not covering the whole resource field. They were limited to six major topics. On the whole their selections were very good.

This authorative, well written book should prove very popular.

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Methods of Farm Management Investigations (F.A.O. Agricultural Development Paper No. 64), W. Y. Yang. Rome: Food and Agriculture Organization of the United Nations, 1958. Pp. ix, 228. $2.00 or 10s.

This booklet will play a significant role in the development of farm economics in the emerging nations. It was written as a guide or operating manual for those conducting research, and as an introductory text for those teaching research methodology, in the underdeveloped countries. We used the booklet last summer at Hokkaido University as our basic text in a 6 weeks research training course for Japanese professional farm management workers. Two years of farm management work in Thailand and Japan gives me a much greater appreciation for the value of this publication.

Dr. Yang has packed a wonderful coverage of methodology into the 228 pages. Operating procedures, accompanied by concise discussions of the methods and by brief cautions in their use, include these subjects:

1. Farm Business Survey
2. Farm Bookkeeping and Financial Accounting
3. Farm Business Analyses
4. Cost and Enterprise Studies
5. Marginal Analysis of Input-Output Relationships
6. Farm Planning, Budgeting and Programming
7. Farm Work Efficiency Studies
8. Estimating Machinery Costs and Planning Its Efficient Use
9. Cost-Benefit Appraisal of Agricultural and Farm Projects
10. Land Tenure Problems

An eleventh section brings together the literature cited.

The emphasis is upon applied research, which is as it should be in this F.A.O. publication. "The importance of a clear vision of the actual use to which a farm management research project is to be put before it is undertaken can never be overemphasized" (p. 7). The research worker or teacher who uses the manual is well advised to have some prior training in the subject, because the brief instructions cannot cover all situations.

Brevity increases readability but, on some points, it results in oversimplification or omission of alternatives and ramifications. Dr. Yang chose brevity; a wise decision for this kind of publication. No one volume

can tell all that is known on the subject, nor can one small book give all the pros and cons of various research techniques.

Clarity is vital when writing for an international audience who may be reading in their second language. The author's choice of words and sentence construction is a good example for international writers.

Examples and illustrations used in the booklet draw upon many studies and upon Dr. Yang's own broad experience in several countries. This is effective, particularly when the reader is conducting research outside the United States.

The author has offered numerous cautions to the reader on the use of the various techniques, limitations or weaknesses of the methods, and need of special data for certain analyses. This is a good idea; perhaps one is justified in saying that such precautions are essential, since the techniques are applied in geographic areas where the methods have not evolved through the normal development processes. This abridged evolution results in some technicians, often not fully trained, misusing the techniques in various ways (data not suitable, analysis not satisfactory for the situation, or results not acceptable without modification in the cultural setting). However, these necessary warnings can result in an overly pessimistic outlook. For example, Chapter 5 on input-output analysis and the section on linear programming (Chapter 6) do not reflect the most recent modifications of these analytical techniques (e.g. p. 120, last paragraph or p. 152, Assumption C). This makes Yang's cautions and limitations too conservative, inasmuch as recent modifications permit some of these analytical methods to handle more situations than he describes as suitable for analysis.

The chapter on Cost-Benefit Appraisal does not cover the effect of scale upon both the unit costs and the total benefits. Much of the research of this nature may have been done since the manuscript was prepared. The numerous reclamation projects being planned for underdeveloped areas might well include this aspect of the cost-benefit appraisals.

I commend highly this F.A.O. publication to those in agricultural economics who are teaching or doing research in the underdeveloped countries. I believe that those who are training scholars for service in these countries will want each student to have a working knowledge of the contents of this booklet. All teachers of farm management principles or research methods may well consider this concise, jam-packed volume for reference reading for both undergraduate and postgraduate students. Editions are now available in English, French, and Spanish. F.A.O. has granted permission for scholars at Hokkaido University and in Taiwan to translate the publication into Japanese and Chinese.

In view of the considerable wear to which so useful a book is subjected, it is to be hoped that future printings might be more durably bound.

C. V. PLATH

Oregon State College

Marketing Problems and Improvement Programs (FAO Marketing Guide No. 1.), J. C. Abbott. Rome: Food and Agriculture Organization of the United Nations, 1958. Pp. xiii, 260. $2.50 or 12s. 6d.

Most of the published material dealing with economic development underemphasizes the problem of marketing. Yet it should be apparent that improvements in production in many cases must await improvements in marketing. It is encouraging to find a book dealing specifically with this subject.

This book is not written for professional economists. Rather it "is intended to be of practical assistance to marketing advisers and administrators, to marketing organizations, and to state, co-operative or private concerns handling agricultural produce. . . ." In the judgment of this reviewer the book will serve this audence well. Professional economists contemplating overseas work will find this book helpful, as well.

Following the introduction is a thirty-five page section entitled, "What Marketing Means." This section is devoted to an explanation of standard marketing terms and concepts. It includes a seven page discussion of price theory. This textbook approach is likely to be lost on the audience for which the book is intended. Professional economists will be annoyed by some of the errors in price theory. For example, it is proposed that goods which have a high price elasticity of demand will be more responsive to income changes than those with a low price elasticity. This reviewer is not aware of support for this positive correlation between price elasticity and income elasticity of demand.

The next section of the book describes typical marketing problems associated with economic development. The traditional marketing functions are used as the basis of organization for this section. Anyone who has worked in underdeveloped countries will recognize the problems which are discussed. Reference is made to actual experiences throughout the world to clarify the nature of these problems. They are presented in such a way that it seems unlikely that anyone from any of the countries concerned could take offense. The emphasis is on objective definition of problems and possible solutions.

Some of the suggested solutions are questionable. For example it is proposed that freight rates be tied to agricultural prices. This would tend to reduce the impact of low prices. But this assumes either a high level of

knowledge about agricultural price movements or possibly subsidized rates. Another questionable solution relates to the use of compulsory grade standards for export products. It is suggested that voluntary grade standards are to be preferred because they are more likely to be changed when market requirements change. This may be true. But it is also true that use of good compulsory grade standards may enhance the market for export products more than is possible when only part of the products are graded.

The final section of the book is concerned with "Introduction of Improvements." In this section we find that improvements in the markets for agricultural products may be (and have been) initiated by profit-seeking marketing firms, by farmers' cooperatives, or by government agencies. Again this section is illustrated by extensive reference to experiences throughout the world. This reviewer is particularly pleased with the reference to improving markets through action of profit-seeking marketing firms. All too often such improvements are prevented by restrictive legislation.

This is a well written and needed book. The criticisms suggested by this reviewer are of minor importance. It will not only serve the audience for which it is intended but will be an important reference for college students as well.

EDWARD H. WARD

Montana State College

NEWS NOTES

Bushrod W. Allin, of Agricultural Marketing Service, USDA, has been in New Delhi on a three-months' assignment with the International Cooperation Administration, advising the Government of India on the development of Outlook and Situation work. He is expected to return to Washington in May after completing a trip around the world.

Carl G. Anderson, Jr., who recently completed requirements for the M.S. in Agricultural Economics at Louisiana State University, has joined the Texas A. and M. College Staff as Farm Management Specialist with the Vocational Agricultural Division of the Texas Education Agency and the Department of Agricultural Economics and Sociology.

Emery G. Anderson, who completed his M.S. at Montana State College, joined the Department of Agricultural Economics, North Dakota Agricultural College, as Assistant Agricultural Economist in Livestock Marketing effective April 1.

George H. Aull, Head, Department of Agricultural Economics and Rural Sociology, Clemson College, was recently elected Chariman of the Board of Directors, Charlotte Branch, Federal Reserve Bank of Richmond.

Frank D. Barlow, formerly in charge of cooperative research for AMS at the Southern Utilization Research and Development Laboratory, ARS, at New Orleans, has transferred to the ARS Product and Process Evaluation Staff.

Jules F. Bauermann, formerly of Rutgers University, joined the Agricultural Economics Extension staff at Pennsylvania State University on October 1, 1959.

Clare A. Becker, Pennsylvania State University, has taken sabbatical leave until August 1 and is working with the Marketing Economics Research Division, Agricultural Marketing Service, USDA.

Marcell L. Beckford, who received his M.S. at Penn State in January, has accepted a research appointment in the Department of Agricultural Economics at Cornell University.

Owen D. Belcher has resigned as Assistant in Agricultural Economics at Auburn University to accept a position with the U.S. Study Commission, Southeast River Basins, in Atlanta, Georgia.

Lloyd W. Bergsma, formerly farm management specialist with the Vocational Agriculture Division of the Texas Education Agency, has accepted a position as livestock marketing specialist with the Texas Agricultural Extension Service.

James M. Blaut, on leave from Yale University, is Visiting Assistant Professor at Cornell, teaching Agricultural Geography in the absence of J. W. Mellor.

Richard A. Blood joined the staff of the Farm Economics Research Division, ARS, in November and is stationed at Raleigh, N.C.

Dewey O. Boster, Statistician in Charge, Harrisburg, Pa., Agricultural Estimates Division, AMS, received a Superior Performance Award on March 7, for exemplary performance, initiative, and effective leadership in the development of expanded and improved public service through the cooperative agricultural statistical and reporting program in Pennsylvania.

Victor Bowman has returned to the Marketing Economics Research Division, AMS, after nine years with the International Cooperation Administration.

H. Austin Brockway has resigned from his position at the University of Arkansas and is now affiliated with a private organization.

William J. Brunk, Agricultural Estimates Division, AMS, Office of the State Statistician in Oklahoma, moved to the Field Crops Branch in Washington, D.C., on November 29, 1959.

Charles E. Burkhead, Chief, Field Crops Statistics Branch, Agricultural Estimates Division, AMS, received on February 18 a Superior Performance Award for effective and resourceful leadership in the development of estimating programs on cotton, grains, and other field crops.

Robert J. Byrne has been appointed Chief of the Transportation Branch, Management Services Division, Farmer Cooperative Service. He began his government service in 1948 with the Transportation Section of Farm Credit Administration. He transferred to the Transportation Branch when Farmer Cooperative Service was established in 1953.

Russell L. Childress, formerly with the Division of Agricultural Economics Programs, Federal Extension Service, accepted a research professorship with the University of Delaware, effective February 1, for work in wholesale and retail food distribution.

George W. Clark, Agricultural Research Service, USDA (stationed at Auburn University), has returned to his research duties following a period of military leave.

Leonard M. Conyers has retired as Chief, Transportation Branch, Management Services Division, Farmer Cooperative Service, after 26 years with the Department of Agriculture.

Joseph M. Cowden has returned to the Dairy Branch, Marketing Division, Farmer Cooperative Service, from the International Cooperation Administration, New Delhi, India.

William M. Crosswhite, who recently completed the requirements for the Ph.D. at Michigan State University, was appointed Assistant Professor at the University of Delaware, effective January 15. He will do teaching and research in farm management and production economics.

Larry L. Dennison, who completed his M.S. at the University of Minnesota, has accepted a position as Extension Economist at Virginia Polytechnic Institute.

B. A. Dominick, Jr., of Cornell University, is serving on a committee selected by Federal Extension Service to visit several Latin American countries and obtain first hand information on foreign trade problems and potentials.

Norbert A. Dorow, who completed work for the Ph.D. at University of Minnesota, joined the staff at North Dakota Agricultural College in April as Assistant Professor and Assistant Agricultural Economist in Farm Management and Land Economics.

Harland C. Doughty, formerly with the Marketing Economics Research Division, AMS, is now with the Commodity Stabilization Service.

Gale E. Ewald, Agricultural Estimates Division, AMS, transferred from Office of the State Statistician in Wisconsin to Office of the State Statistician in Colorado, effective December 21.

Jack Fleischer, of the North Carolina Statistical Laboratory, became Assistant Professor in the Department of Experimental Statistics, North Carolina State College, on January 1.

A. O. Follett, Extension Specialist in Farm Management at the University of Wisconsin, retired with Emeritus status on January 1.

John F. Fritschen, Farm Economics Research Division, ARS, formerly stationed at Salt Lake City, is now on the staff at Washington, D.C.

MILTON GRIFFING completed his work for the M.S. at North Dakota Agricultural College in December and on January 1 was made Instructor in the Agricultural Economics Department at the University of Nebraska.

ZVI GRILICHES has been appointed Associate Professor at the University of Chicago with tenure.

VAN. B. HART retired December 31 after forty years on the Cornell staff. Most of his work was in farm finance and farm management extension.

LOYAL M. HARTMAN resigned from the Farm Economics Research Division, ARS, in December, and has taken a position at Colorado State University.

EARL O. HEADY, of Iowa State University, received the honorary degree, Doctor of Science, from the University of Nebraska at the mid-winter commencement.

WALTER A. HENDRICKS retired as Chief, Research and Development Staff, Agricultural Estimates Division, AMS, on February 29 and on March 1 joined the staff of the Statistics Research Division, Research Triangle Institute, Durham, N.C.

DANIEL L. HERBERT, Agricultural Estimates Division, AMS, transferred on November 29 from the Office of the State Statistician in Colorado to the Washington, D.C., office, Livestock and Poultry Statistics Branch.

JAMES B. HERENDEEN has been appointed Research Associate in the Department of Economics and Sociology at Iowa State University (Ames).

OPIE C. HESTER has transferred from the Marketing Economics Research Division to the Market Development Research Division, AMS. He will be stationed at the ARS Southern Utilization Research and Development Laboratory at New Orleans and will be in charge of cooperative research projects for AMS.

RANDALL A. HOFFMANN has been promoted to Assistant Professor in the Department of Economics and Sociology at Iowa State University (Ames).

BALDER HOHENBALKEN has been appointed Research Associate in the Department of Economics and Sociology at Iowa State University (Ames).

ANDREAS A. HOLMSEN, who completed work for the Ph.D. at Cornell, was made Assistant Professor in Marketing and Assistant Agricultural Economist in the Department of Agricultural Economics at North Dakota Agricultural College in March.

PETER W. HOUSE, who recently completed work for his M.S. at Clark University, has joined the Washington staff of the Farm Economics Research Division, ARS, where he will work on farm taxation and rural government problems.

HARRISON HSIA has completed the requirements for the Ph.D. at the University of Wisconsin and has taken a temporary position with the Extension Service of the Manitoba Department of Agriculture and Immigration in Winnipeg.

D. GALE JOHNSON, University of Chicago, has been appointed chairman of the Committee on Agricultural Policy of the Agricultural Board of the National Academy of Sciences. The purpose of this committee is to study the relationship between science and agriculture and the problems of appropriate organization of agricultural research in the United States.

ARCADIUS KAHAN has been appointed Assistant Professor at the University of Chicago.

ROBERT C. KRAMER will become Director of the National Center for Agricultural Processing, Utilization and Marketing to be established at Michigan State University.

Wayne A. Lee resigned as Professor of Marketing, Pennsylvania State University, effective February 15, to become Director of the Distribution Research Division, Market Research Corporation of America.

Robert C. McElroy, who recently received his B.S. from Virginia Polytechnic Institute, has joined the Washington staff of the Farm Economics Research Division, ARS. He will work on farm labor problems.

E. E. McLean was made Second Vice President of the Equitable Life Assurance Society of the United States in February. He had been made Head of the Farm Mortgage Department in January.

Frank Meissner has resigned from the Marketing Research Department of the Crown Zellerbach Corporation and from the faculty of Golden Gate College, San Francisco, to accept a position as Industrial Economist with the Stanford Research Institute, Menlo Park, California.

Joseph F. Metz, Jr., was appointed Assistant Director of the Cornell Agricultural Experiment Station and Assistant Director of Research for the New York State College of Agriculture as of March 1. He will continue his work in the Agricultural Economics Department until June 30.

Donald S. Moore was recently appointed an associate member of the graduate faculty of Texas A. and M. College.

Elmer J. Moore, formerly of the Marketing Economics Research Division, AMS, is now with the Outdoor Recreation Resources Review Commission.

Russell H. Moore retired as Professor Emeritus of Agricultural Economics at Ohio State University on March 1.

Thomas Moore, formerly of the University of Massachusetts, joined the Agricultural Economics Extension staff at Penn State on February 1. He will serve as Area Marketing Agent for southeastern Pennsylvania.

Kenneth D. Naden, formerly Agricultural Counsel with the National Association of Food Chains, was appointed Administrative Counsel of the National Council of Farmer Cooperatives on March 1.

Aldon D. Nielsen, of the U. S. Bureau of Reclamation, has transferred from the Lower Platte River Investigations Field Office to the Office of the Assistant Commissioner and Chief Engineer at Denver, where he will serve as a technical advisor in agricultural economics for regional and project personnel in the 17 western states.

Frank Overley, formerly Instructor in Farm Management, University of Connecticut, joined the staff of Kansas State College on February 1 as Extension Farm Management Specialist.

Anthony Pavlick, on leave for one and one-half years at the University of West Virginia, returned to the staff of South Dakota State College on March 1.

Harald C. Pederson, Extension Economist at the University of Minnesota, has been promoted to Associate Professor.

Maurice Perkins, formerly with the International Bank for Reconstruction and Development in Washington, D.C., has joined the staff of Michigan State University as Professor of Agriculture and International Programs.

A. L. Perry, University of Maine, was on leave of absence during February and March to serve as Agricultural Consultant to the Venezuelan Government to develop a grading and inspection service for potatoes.

Luther J. Pickrel, Extension Economist at the University of Minnesota, has been promoted to Associate Professor.

Paul A. Pilati, Farm Economics Research Division, ARS, formerly stationed at Bozeman, Mont., is now at Madison, Wis.

GERALD G. QUACKENBUSH became Director of Marketing Research for the American Dairy Association effective March 1.

CHARLES E. RAYMOND transferred last July 1 from the Underwriting Division of the Federal Crop Insurance Corporation, USDA, to the Cotton and Other Fibers Section, Statistical and Historical Research Branch, AMS, with responsibility for preparing *The Wool Situation.*

ARTHUR ROBERTS, who was stationed in Tucson, Arizona, on the staff of the Marketing Economics Research Division, AMS, for many years, retired last December.

GEORGE ROGERS, of the Marketing Economics Research Division, AMS, has transferred from Durham, N.H., to Washington, D.C.

JOHN C. ROSS, JR., of the Marketing Economics Research Division, AMS, has transferred from the Stoneville, Mississippi, office to the station at Clemson, South Carolina.

R. OTIS RUSSELL recently resigned as Extension Livestock Marketing Specialist at Virginia Polytechnic Institute to accept a similar position at Auburn University.

GLENN SAMSON, formerly with the Marketing Economics Research Division, AMS, is now with the Livestock and Meat Products Division, Foreign Agricultural Service, USDA.

LYLE P. SCHERTZ is now research fellow in agricultural economics at the University of Minnesota. He was formerly with the Pillsbury Company.

RAYMOND SCHULTZ, formerly of Ohio State University, joined the staff at South Dakota State College on March 21 as Assistant Professor of Economics.

T. W. SCHULTZ has been elected President of the American Economic Association for 1960. On February 15 he lectured at the National War College in Washington, D.C., on Economic Development in Latin America. In June he will head a team of United States economists who will visit the U.S.S.R. and he will then go to Italy to participate in a conference on Economic Aspects of Educational Development in Europe, to be held at Lake Como, July 20-30.

MERVIN G. SMITH, Head of the Department of Agricultural Economics and Rural Sociology, Ohio State University, is on leave as a visiting professor at the Center for Agricultural and Economic Adjustment, Iowa State University.

HEINZ SPIELMAN joined the staff of the Department of Agricultural Economics and Rural Sociology at Montana State College on April 4.

B. F. STANTON, of Cornell University, is spending his sabbatical leave, February through August 1960, working in the Agricultural Economics Division, AMS. He is studying the use of quarterly data in demand and supply analyses for livestock and meats during the post-war period.

JAMES A. STREET has resigned from the Marketing Economics Research Division of AMS and is now with the Kentucky Department of Economic Development in Frankfort, Kentucky.

KENNETH R. TEFERTILLER was recently appointed an associate member of the graduate faculty of Texas A. and M. College.

BEN THIBIDEAUX, former member of the old Bureau of Agricultural Economics Division of Farm Management and Costs and in recent years with the State Department, has retired from Government Service.

JOSEPH G. THOMAS, Agricultural Estimates Division, AMS, transferred on January 25 from the Office of the State Statistician in Illinois to the Office of the State Statistician in Kansas.

FRED G. THORP, Agricultural Estimates Division, AMS, transferred on January 24 from the Office of the State Statistician in Kansas to the Office of the State Statistician in Oklahoma.

GEORGE VON TUNGELN, of Clemson College, was promoted last July 1 to Associate Agricultural Economist and Associate Professor of Economics.

OMAR WAHBY has been appointed Research Associate in the Department of Economics and Sociology at Iowa State University (Ames). Dr. Wahby is on sabbatical leave from the Department of Agricultural Economics, University of Cairo, in Egypt.

GEORGE WANGER, JR., Agricultural Estimates Division, AMS, transferred on February 8 from the Livestock and Poultry Statistics Branch in the Washington office to the Office of the State Statistician in Illinois.

BILLY WEBB has accepted a position as ARS cooperative agent at the University of Arkansas.

CARL F. WEHRWEIN, of the Foreign Agricultural Service, USDA, recently spent five weeks in England, Belgium, Netherlands, West Germany and Italy to determine the extent to which the non-tariff import restrictions of those countries have limited their imports of grains from the United States.

ROBERT I. WESSEL joined the staff of the Farm Economics Research Division, ARS, in December and is stationed at Ames, Iowa.

MOYLE S. WILLIAMS, formerly with the National Plant Food Institute, was appointed chief economist of the Sulphur Institute, effective March 16. He will be located at the Washington headquarters of the Institute.

LOWELL E. WILSON, who recently completed requirements for a Ph.D. degree at the University of Illinois, has been appointed Assistant Agricultural Economist at Auburn University. He will be engaged in full-time research in dairy marketing.

MARY B. WOOD, of Cornell University, became Assistant to the Dean of the College of Home Economics on January 31. She was formerly Extension Home Economist in Marketing.

M. D. WOODIN, Director of Resident Instruction for the College of Agriculture at Louisiana State University, has been made Dean of the new branch college of the University at Alexandria, Louisiana.

A. B. WOOTEN assumed chairmanship of the Land Economics Section in the Department of Agricultural Economics and Sociology, Texas A. and M. College, on February 15. He was formerly extension economist with the Texas Agricultural Extension Service.

CARLETON E. WRIGHT has returned to his position as Extension Economist at Cornell after spending a sabbatical leave preparing a textbook on consumer food marketing.

OBITUARY

DELLA MERRICK, who retired in 1958 from the Farm Economics Research Division, ARS, passed away on February 21, following a stroke. Miss Merrick was for many years a statistician with the Division of Farm Management and Costs of the former Bureau of Agricultural Economics.

ORGANIZATIONAL ANNOUNCEMENTS

The Eleventh International Conference of Agricultural Economists is to be held August 19-30, 1961, in Cuernavaca, near Mexico City. Three tours are being arranged for the week following the Conference: one in the central area around Mexico City, one in tropical Mexico, and one in the irrigated area of the northwest. Information regarding the Conference can be obtained from the Secretary, Joseph Ackerman, Farm Foundation, 600 South Michigan Avenue, Chicago 5, Illinois.

The 1960 annual meeting of the Western Farm Economics Association will be held at Stanford University on August 23-26. WFEA will meet concurrently with the American Statistical Association and the Western Economic Association.

The Second European Congress of Rural Sociology will be held August 1-6, 1960 at the Agricultural College of Norway. Congress papers and discussions will focus on the changing structure and functions of rural communities, rural organizations in a changing society, and changes in rural occupational structure and labor organization. The Congress is being organized by the Norwegian Society for Rural Sociology on behalf of the European Society for Rural Sociology. Information may be obtained from the Congress Secretariate, Postbox 53, Vollebekk, Norway.

The Executive Committee of The American Farm Economic Association has given approval to a request of the Johnson Reprint Corporation, 111 Fifth Avenue, New York, to reproduce, in bound form, the unavailable volumes and issues of the *Journal of Farm Economics.* The Corporation proposes to initiate the program with the reprinting of Volumes 1-5 and to consider at a later date the reprinting of Volumes 6-8.

The Center for Agricultural and Economic Adjustment, Iowa State University, is conducting a conference, "Dynamics of Land Use," in May. A conference, "Goals and Values in Agricultural Policy," will be held June 27, 28, and 29. The second national economics conference for agricultural editors was held April 29 and 30, for the purpose of providing the agricultural press information and a greater understanding for policy analysis and reporting.

The Committee on Special Classifications of the Special Libraries Association and the Classification Committee of the Cataloging and Classification Section, Resources and Technical Services Division, American Library Association, are cooperating in a continuing project to develop and expand a Loan Collection of library classification schemes originally established by the Special Libraries Association. This Collection covers all fields of science, law, medicine, technology, the social sciences and the humanities.

New libraries or libraries with special collections are constantly asking for classifications—in all areas of knowledge—and it is imperative that the Collection be kept up-to-date through the addition of new schemes or with modernized versions of existing classification schedules. Curators of special collections, special librarians, and those individuals who have developed special classification schemes for specific types of material or for special subjects are invited to

contribute a copy of their work to the Collection. Classification schemes should be sent to Dr. Jesse H. Shera, Curator, SLA Loan Collection, School of Library Science, Western Reserve University, Cleveland 6, Ohio.

The Food Research Institute of Stanford University has begun publication of *Food Research Institute Studies,* which will contain articles by staff members reflecting their current research interests. It will be published three times a year, in February, May, and September.

The Department of Agricultural Economics, University of Missouri, has obtained four graduate fellowships under the National Defense Education Act beginning fall 1960. The program supports expansion of teaching and research in the area of resource economics.

PH.D. DEGREES CONFERRED IN AGRICULTURAL ECONOMICS, 1959

RAYMOND ANDERSON, B.S. University of Minnesota 1951; M.S. University of Minnesota 1954; Ph.D. University of Wisconsin 1959, Problems of Private Land Use for Recreation in Wisconsin.

RICHARD AUGUSTUS ANDREWS, B.S. University of Maine 1949; M.S. Pennsylvania State University 1951; Ph.D. University of Minnesota 1959, A Study of the Sweet Corn Industry in the Midwest Farm Economy.

RICHARD DAVISON APLIN, B.S. University of Vermont 1951; M.S. Cornell University 1952; Ph.D. Cornell University 1959, Comparative Costs of Country Handling of Milk—Bulk Assembly vs. Can Assembly.

DANIEL BASILE, B.S. University of Connecticut 1942; M.S. Cornell University 1956; Ph.D. Cornell University 1959, Development and Critical Analysis of the Food Program of the Military Forces of the United States.

ROBERT DANIEL BELL, B.S. Alcorn A & M College 1951; M.S. Cornell University 1955; Ph.D. Cornell University 1959, Methodological Problems and Possibilities in Farm Business Analysis with Special Reference to New York State.

RENE BENALCAZAR-RUALES, B.S. Colegio Teodoro Gomez, Ibarra, 1952; M.S. University of Wisconsin 1957; Ph.D. University of Wisconsin 1959, Toward A Program for Agricultural Development in Ecuador.

LLOYD DALE BENDER, B.S. University of Arkansas 1955; M.S. University of Arkansas 1956; Ph.D. University of Missouri 1959, Consumer Preferences for Interior Quality of Eggs.

LOUIS BERNINGER, B.S. Michigan State College 1951; M.S. Michigan State College 1954; Ph.D. University of Wisconsin (joint with Horticulture), Economic Analysis of the Wisconsin Floriculture Industry With Special Reference to the Wholesale Commission Firms.

ROLAND CHANT BEVAN, B.S. University of Minnesota 1923; M.S. University of Minnesota 1937; Ph.D. University of Illinois 1959, Optimum Combinations of Crops and Commercial Fertilizer on Paloust Wheat-Pea Farms.

BILLY J. BOND, B.S., University of Missouri 1953; M.S. University of Illinois 1958; Ph.D. University of Illinois 1959, An Economic Analysis of Local Fertilizer Mixing Plant Operation and Location in Illinois.

JOHN RONALD BRAKE, B.S. Michigan State University 1955; M.S. Michigan State University 1956; Ph.D. North Carolina State College 1959, Prediction of Fertilizer Consumption in Two Regions of the United States.

MICHAEL FRASER BREWER, B.S. Yale University 1953; M.S. University of Michigan 1955; Ph.D. University of California 1959, Water Pricing and Allocation with Particular Reference to California Irrigation Districts.

BRUCE L. BROOKS, B.S. University of Idaho 1943; M.S. University of Idaho 1950; Ph.D. Purdue University 1959, An Analysis of the Washington Wheat Market Relative to Futures Trading.

CLARON BURNETT, B.S. Oklahoma A & M College 1942; M.S. University of Wisconsin 1947; Ph.D. Oklahoma State University 1959, Farmer Evaluation of Procurement Policies and Practices of a Selected Group of Dairy Processing Firms.

RUEBEN CHARLES BUSE, B.S. University of Minnesota 1954; M.S. University

of Minnesota 1956; Ph.D. The Pennsylvania State University 1959, The Relationship of Marketing, Prices and Costs to Marketing Margins for Farm Foods.

HERBERT WALTER BUTT, B.A. Osmania University (India) 1939; M.S. University of Tennessee 1955; Ph.D. Cornell University 1959, A Comparative Study of Local Government in a New England Town and a North Carolina County.

DALE HERBERT CARLEY, B.S. Ohio State University 1955; M.S. Ohio State University 1956; Ph.D. Ohio State University 1959, The Effect of Price on the Supply Response of Milk in Two Ohio Markets.

NEAL ROSS CARPENTER, B.S. Ohio State University 1953; M.S. Ohio State University 1954; Ph.D. Ohio State University 1959, An Extension Method of Farm Management Training.

CHIEN ING CHENG, B.S. Dochisha University, Kyoto, Japan, 1946; M.S. University of Tennessee 1956; Ph.D. Michigan State University 1959, Economic Development and Geographical Disparities in Farm Wage Rates in Michigan, 1940-57.

JOHN BENNETT CLAAR, B.S. University of Illinois 1947; M.S. University of Illinois 1948; Ph.D. University of Illinois 1959, The Cooperative Extension Service and Management Decisions of Farm Families.

IRVING FRANKLIN DAVIS, JR., B.S. University of California 1940; M.S. University of Illinois 1942; Ph.D. University of California 1959, An Economic Analysis of Saving in Agriculture, with Special Reference to California.

CARLETON CECIL DENNIS, B.S. Michigan State College 1954; M.S. Michigan State University 1956; Ph.D. University of California 1959, Interregional Competition in the Frozen Strawberry Industry.

JOHN LOUIS DILLON, B.S. University of Sydney, Australia, 1952; Ph.D. Iowa State University 1959, An Empirical Comparison of Theoretical and Actual Decision Making Under Uncertainty.

LOUIS VERNON DIXON, B.S. University of Connecticut 1950; M.S.A. University of Connecticut 1955; Ph.D. University of Florida 1959, Pricing Efficiency of Marketing Beef Cattle in South Florida.

PETER PAUL DORNER, S.B. University of Wisconsin 1951; M.S. University of Tennessee 1953; Ph.D. Harvard University 1959, The Economic Position and Potential for Development of the American Indians and Their Resources.

JEANNE EBBERT DOST, A.B. Washington State College 1951; A.M. Radcliffe College 1953; Ph.D. Radcliffe College 1959, An Interregional Analysis of the Three Major Wheat Producing Regions.

DIEDRICH DYCK, B.S. University of Saskatchewan 1954; M.S. University of Nebraska 1956; Ph.D. University of Wisconsin 1959, Enterprise Selection for the Economic Development of Part-time Farm in Wisconsin.

HAROLD J. ECKER, B.S. Ohio State University 1955; M.S. Ohio State University 1956; Ph.D. Ohio State University 1959, A Management Audit of Forty-Four Country Elevators in Western Ohio.

WILLIS GEORGE EICHBERGER, B.S. University of Nebraska 1940; M.A. University of Nebraska 1954; Ph.D. Iowa State University 1959, Economic Evaluation of Drainage Benefits.

LUDWIG M. EISGRUBER, B.S. University of Munich 1955; M.S. Purdue University 1957; Ph.D. Purdue University 1959, The Effect of Laying Flock Size on the Economics of Egg Production in North-eastern Indiana.

Shuh-ching Fan, B.A. (equivalent) Taiwan Provincial Institute of Public Administration 1951; M.S. Cornell University 1957; Ph.D. Cornell University 1959, The Causes of Variability in Yields, Costs and Returns in Apple Production in Western New York, 1956 and 1957.

Louis Albert Fourt, A.B. University of Missouri 1939; A.M. University of Chicago 1950; Ph.D. University of Chicago 1959, Empirical Income Elasticities for Food and Its Component Values Produced by Farmers, Manufacturers and Other Marketing Agencies in the United States, 1929-1956.

Wayne Arthur Fuller, B.S. Iowa State University 1955; M.S. Iowa State University 1957; Ph.D. Iowa State University 1959, A Non-Static Model of the Beef and Pork Economy.

Leon Garoian, B.S. Colorado State Polytechnic Institute 1947; M.S. University of Wisconsin 1955; Ph.D. University of Wisconsin 1959, Changes in the Market Structure of Food Retailing, 1940-1957.

Richard Dean Gibb, B.S. University of Illinois 1951; M.E. University of Illinois 1955; Ph.D. Michigan State University 1959, Economies of Scale in Michigan Livestock Auctions.

Howard C. Giles, B.S. Kent University 1949; M.S. Kent University 1956; Ph.D. Purdue University 1959, A Case Study of the Indiana Restaurant Association.

Jesse Cother Grady, Jr., B.S. Texas A & M College 1949; M.S. Texas A & M College 1950; Ph.D. University of Missouri 1959, The Vegetable Industry of Missouri.

Nadim George Hajjar, A.B. American University of Beirut 1945; Ph.D. University of California 1959, Intraregional Trade in the Arab Near East, with Emphasis on the Products of Agriculture.

Harry E. Hathaway, B.S. Oklahoma State University 1940; M.S. Michigan State University 1942; Ph.D. Louisiana State University 1959, Determination of Table Egg Prices in a Deficit Area in Relation to Central Market Quotations.

John Raymond Hildebrand, B.A. University of California 1949; M.A. George Washington University 1951; Ph.D. University of Chicago 1959, Geographical Differentials in the Earning Power of Input Categories on Kansas Farms.

Peter Edward Hildebrand, B.S. Colorado State University 1955; M.S. Colorado State University 1956; Ph.D. Michigan State University 1959, Farm Organization and Resource Fixity: Modifications of the Linear Programming Model.

James Francis Hudson, B.S. Louisiana State University 1942; M.S. Louisiana State University 1945; Ph.D. Iowa State University 1959, Accuracy of Pricing Cottonseed for Crushing Purposes in Louisiana.

Rufus Britton Hughes, Jr., B.S. Oklahoma A. & M. College 1948; M.S. Oklahoma A. & M. College 1950; Ph.D. University of Chicago 1959, Low Incomes in Southern Agriculture.

Phimol Jittemana, LL.B. Thammasat University, Bangkok, 1952; Ph.D. University of Wisconsin 1959, Agriculture In A Developing Economy—A Midcentury Appraisal of Thailand's Agriculture.

Paul Reynold Johnson, B.A. Oberlin College 1950; M.S. North Carolina State College 1953; Ph.D. University of Chicago 1959, Land Substitutes and Corn Yields.

MONTE E. JUILLERAT, B.S. Purdue University 1956; M.S. Purdue University 1958; Ph.D. Purdue University 1959, The Pricing Structure for Soybeans at Country Elevators and Processors in Indiana.

MYRON P. KELSEY, B.S. Cornell University 1953; M.S. Cornell University 1956; Ph.D. Purdue University 1959, Economic Effects of Field Renting on Resource Use on Central Indiana Farms.

A. ROBERT KOCH, B.S. Rutgers University 1953; M.S. Purdue University 1955; Ph.D. Purdue University 1959, Interregional Competition in the Tomato Processing Industry.

GANGADHAR S. KORI, B.S. University of Bombay 1947; M.S. Karnatuk University (Bombay) 1953; Ph.D. South Dakota State College 1959, United States Wheat Surpluses and the Role of the Farmer Organizations in Their Utilization.

RONALD DEAN KRENZ, B.S. North Dakota Agricultural College 1955; Ph.D. Iowa State University 1959, Farm Size and Costs in Relation to Farm Machinery Technology.

ARMAND LUC LACASSE, B.A. Laval University 1949; B.S. McGill University 1953; M.S. Cornell University 1956; Ph.D. Cornell University 1959, Costs and Efficiency in the Operation of Milk Manufacturing Plants in the New York–New Jersey Milkshed.

ROBERT E. LAUBIS, B.S. Ohio State University 1949; Ph.D. Ohio State University 1959, An Analysis of the Financial Structure of Agricultural Cooperative Business Organizations in Ohio and Suggestions for Improvement.

JERRY MCHUGH LAW, B.S. Louisiana State University 1942; M.S. Louisiana State University 1948; Ph.D. University of Minnesota 1959, The Development of a Classification of Market Structures for Agriculture.

KARL HARTVIG LINDEBORG, B.S. Royal Veterinary and Agricultural College, Copenhagen 1947; M.S. Utah State Agricultural College 1956; Ph.D. Oregon State College 1959, Economic Effects of Different Allocations of Ground Water within Agriculture in the Milton-Freewater Area of Oregon.

JOHN YAOTUNG LU, B.S. Berea College 1955; M.S. Michigan State University 1957; Ph.D. Michigan State University 1959, Application of a First Order Autoregressive Model to Some Economic Relations.

RUSSELL GEORGE MAWBY, B.S. Michigan State University 1949; M.S. Michigan State University 1953; Ph.D. Michigan State University 1959, Types and Sources of Information used by Farmers in Michigan, with Implications for Extension Programming.

RUSSELL FUDGE MCDONALD, B.S. Ohio State University 1950; M.S. Ohio State University 1958; Ph.D. Ohio State University 1959, Development and Evaluation of Alternative Methods of Preparing Fleece Wool for Market.

HENRY JOHN MEENEN, B.S. Kansas State College 1940; M.S. Kansas State College 1943; Ph.D. University of Missouri 1959, The Impact of a Flood Control Project Upon the Economic and Social Structure of the Area.

CHARLES VINCENT MOORE, B.S. Ohio State University 1953; M.S. Ohio State University 1956; Ph.D. Ohio State University 1959, An Evaluation of Farm Accounting Systems as Aids to the Management of Commercial Farms.

JOHN RUNYON MOORE, B.S. Ohio State University 1951; M.S. Cornell University 1955; Ph.D. University of Wisconsin 1959, Market Structure and Competitive Behavior in the Dairy Industry—The Present State of Knowledge.

KENNETH CHARLES NOBE, B.S. Southern Illinois University, 1953; M.S. Cornell

University 1954; Ph.D. Cornell University 1959, An Agricultural Regions Concept for New York State.

PHILLIP G. OLSON, B.S. University of Arizona 1954; M.S. University of Arizona 1956; Ph.D. Purdue University 1959, Socio-Economic Factors Affecting Labor Mobility in an Indiana Rural Community.

LELAND E. OTT, B.S. Indiana University 1952; M.S. Indiana University 1955; Ph.D. Purdue University 1959, Labor Utilization in Independent Indiana Supermarkets.

P. G. KESAVA PANIKAR, B.A. Annamalai University (India) 1945; Ph.D. Vanderbilt University 1960, An Essay on Rural Savings in India.

EARL JULIUS PARTENHEIMER, B.S. Purdue University 1952; M.S. Purdue University 1955; Ph.D. Michigan State University 1959, Some Expectation Models Used by Selected Groups of Midwestern Farmers.

ARNOLD ALLEN PAULSEN, B.S. Iowa State University 1951; Ph.D. Iowa State University 1959, Evaluation of Production Control Policies With Respect to Agricultural Adjustment.

VERNON W. PHERSON, B.S. Purdue University 1954; M.S. University of Connecticut 1956; Ph.D. Purdue University 1959, The Competitive Potential of the U. S. Cotton Industry.

RONALD HOWARD POLLOCK, B.S. Ohio State University 1948; M.S. Ohio State University 1949; Ph.D. Ohio State University 1959, An Analysis of Changes in Consumer Milk Purchases in Two Ohio Metropolitan Areas.

ROBERT REIERSON, B.S. University of Wisconsin 1948; M.S. University of Wisconsin 1950; Ph.D. University of Wisconsin 1959, Principles of Economics and Education Applied to the Meat Animal Industry of Wisconsin.

ALLEN BAKER RICHARDS, B.S., B.A. Northwestern University 1951; M.S. Montana State College 1955; Ph.D. Iowa State University 1959, Some Effects of Federal Grain Programs on Country Elevators in Iowa.

WALTER BOB ROGERS, B.S. Texas Technological College 1951; M.S. University of Arizona 1953; Ph.D. Oklahoma State University 1959, Costs and Charges for Bulk Milk Assembly in the Oklahoma City Milk Shed.

RONALD STUART RUST, B.S.A. University of Manitoba 1952; B.Ed. University of Alberta 1953; M.A. University of Alberta 1957; Ph.D. University of Illinois 1959, Producer Benefits from the Operations of the Ontario Sugar Beet Growers' Marketing Board.

ALFRED ALLAN SCHMID, B.S. University of Nebraska 1956; M.S. University of Wisconsin 1957; Ph.D. University of Wisconsin 1959, Water Allocation and Development in Wisconsin.

JOHN A. SCHOENEMANN, B.S. University of Wisconsin 1950; M.S. University of Wisconsin 1954; Ph.D. University of Wisconsin 1959 (joint with Horticulture), Effect of Variety and Harvest Date Systems on Economic Returns for Potato Farms in Central Wisconsin.

RICHARD LEE SIMMONS, B.S. Kansas State College of Agriculture and Applied Science 1951; M.S. Kansas State College of Agriculture and Applied Science 1955; Ph.D. University of California 1959, Optimum Adjustments of the Dairy Industry of the Western Region to Economic Conditions of 1975.

HAR SWARUP SINGH, B.S. Amar Singh Jat College, Lakhaoti, India, 1948; M.S. Government Agricultural College, Kanpur, 1950; Ph.D. North Carolina State College 1959, Evaluation of Alternative Income Opportunities for Farm Operators in Macon County, North Carolina.

RAM RATAN SINGH, B.S. Indian Agricultural Institute 1947; Ph.D. Ohio State University 1959, Reorganization of Contiguous Small Farms for the Maximum Economic Returns.

NORTON E. SMITH, B.S. University of Illinois 1951; M.S. Purdue University 1955; Ph.D. Purdue University 1959, Development of a Hog Evaluation System for Packing Plants.

JAMES LARKIN STALLINGS, B.S. Purdue University 1952; M.S. Purdue University 1956; Ph.D. Michigan State University 1959, Indexes of the Influence of Weather on Agricultural Output.

ROBERT DALE STEVENS, A.B. Princeton University 1950; M.S. Cornell University 1955; Ph.D. Cornell University 1959, Capital Formation and Agriculture in Some Lebanese Villages.

JAMES H. STEVENSON, B.S. University of Illinois 1955; M.S. Purdue University 1957; Ph.D. Purdue University 1959, Marketing Meat-Type Hogs and Pork as a Differentiated Product.

KENNETH RAY TEFERTILLER, B.S. Oklahoma State University 1952; M.S. Oklahoma State University 1957; Ph.D. University of Illinois 1959, Economic Optima in Freshening Dairy Cows in Northeastern Illinois.

GUSTAVO ADOLFO TEJADA, B.S. Ohio State University 1955; Ph.D. Ohio State University 1959, Comparative Returns to Resources Used on Different Types and Classes of Farms by Major Types of Farming Areas in Ohio and Neighboring Areas.

GERALD ION TRANT, B.S.A. University of Toronto 1951; M.S. Michigan State University 1954; Ph.D. Michigan State University 1959, A Technique of Adjusting Marginal Value Productivity Estimates for Changing Prices.

AKIRA UCHIDA, B.S. The Pennsylvania State University 1955; M.S. The Pennsylvania State University 1956; Ph.D. Purdue University 1959, Theoretical Models of Interregional Competition in the Poultry Meat Industry.

JOSEPH VON AH, Diploma Swiss Federal Institute of Technology 1955; M.A. University of Nebraska 1957; Ph.D. University of Wisconsin 1959, The Adaptation of Wisconsin Rural Families to Changing Opportunities in Farming, 1950-1958.

LARRY ODELL WALKER, B.S. Ohio State University 1952; M.S. Ohio State University 1957; Ph.D. Iowa State University 1959, Game Theory Application in Agricultural Decisions.

EMIL BOYD WENNERGREN, B.S. Utah State University 1951; M.S. Utah State University 1956; Ph.D. The Pennsylvania State University 1959, Economic Aspects of Producing in the Apple-Processing Industry, Adams County, Pennsylvania, 1956-1958.

WALTER LAVON WILSON, B.S. University of Illinois 1949; M.S. University of Illinois 1952; Ph.D. University of Illinois 1959, Factors Associated with the Incidence of Low Income Farms in Illinois Areas.

HARRY RAYMOND WOLTMAN, Ph.B. University of California 1949; A.M. University of Chicago 1951; Ph.D. Stanford University 1959, The Decline of Argentina's Agricultural Trade: Problems and Policies, 1929-54.

PRELIMINARY PROGRAM FOR ANNUAL MEETING
AMERICAN FARM ECONOMIC ASSOCIATION

IOWA STATE UNIVERSITY, AMES

AUGUST 10-13, 1960

Wednesday, August 10

9:00 A.M. Executive Committee Meeting, AFEA

1:00 P.M. Registration

2:00 P.M. Executive Committee Meeting, AFEA

4:30 P.M. Meeting of the Student Activities Committee with Undergraduate Student Officers and All Students Participating in the 1960 Program

7:00 P.M. Reception

Thursday, August 11

9:00 A.M. Welcome

9:15 A.M. General Session: Continuing the 50th Year Celebration
- An Historian Looks at the Past 50 Years of the Agricultural Economics Profession
- An Economist Looks at the Next 50 Years of the Profession

11:00 A.M. Presidential Address

2:00 P.M. Sectional Meetings
- Invited Papers Sections
  - Potentialities and Limitations of Comprehensive Supply Control
  - Measuring Input Changes in Agriculture
  - Developing an Integrated Extension Program—Production, Marketing, Public Policy—On Agricultural Adjustment Problems
  - The U.S. Department of Agriculture as an Instrument of Public Policy *(Joint Session with the Agricultural History Society)*
- Contributed Papers Sections
  - Teaching Agricultural Economics
  - Land Economics, Farm Finance and Institutional Economics

2:00–
5:00 P.M. Student Debates and Public Speaking Contest

6:00 P.M. Picnic

9:00 P.M. Executive Committee Meeting, AFEA

Friday, August 12

8:30 A.M. General Session: Impact and Implications of Foreign Surplus Disposal on "Underdeveloped Economies"

10:30 A.M. General Session: Impact and Implications of Foreign Surplus Disposal on Developed Economies and Foreign Competitors

2:00 P.M. Sectional Meetings
- Invited Papers Sections
  - The Center for Agricultural and Economic Adjustment—Description and Appraisal
  - Raising Incomes in Low-Production Areas of Agriculture
  - Integration Revisited
  - Existing Programs for Data Processing on Electric Computers
- Contributed Papers Sections
  - Farm Management and Production Economics
  - Consumption, Marketing and Distribution

2:00–4:00 P.M. Student Debates

4:00 P.M. Student Debate Finals

8:00 P.M. Awards Program

Saturday, August 13

8:30 A.M. Annual Business Meeting, AFEA

10:00 A.M. Annual Business Meeting, Student Section, AFEA

10:00 A.M. Sectional Meetings
- Invited Papers Sections
  - Market Power and the Farm Problem
  - The Midwest–Eastern-Seaboard Conflict of Interest in the Production and Distribution of Milk
  - Rural and Urban Competition for Water
  - Problems of Method in Agricultural Economics Research
  - The Farm of the Future

EMPLOYMENT SERVICE

The AFEA Employment Committee will provide placement service for the summer meetings in Ames. Details including job order forms will be sent to department heads and other prospective employers early in July. Application forms for those seeking positions will be available through department heads after July 15. Readers who are interested in either job order or application forms may also obtain them from Professor Ray Beneke, Department of Economics, Iowa State University, Ames, Iowa.